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evolution: science and belief
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report highlights

Three proponents of Intelligent Design (ID) present their views of design in the natural world. Each view is immediately followed by a response from a proponent of evolution (EVO). The report, printed in its entirety, opens with an introduction by Natural History magazine and concludes with an overview of the ID movement.

The authors who contributed to this Natural History report are:

- Richard Milner and Vittorio Maestro, ed. (introduction)
- Michael J. Behe, Ph.D. (ID) and Kenneth R. Miller, Ph.D. (EVO)
- William A. Dembski, Ph.D. (ID) and Robert T. Pennock, Ph.D. (EVO)
- Jonathan Wells, Ph.D. (ID) and Eugenie C. Scott, Ph.D. (EVO)
- Barbara Forrest, Ph.D. (overview)

ActionBioscience.org has added "learn more links" to this report which consist of author-recommended links to online information to help readers learn more about each author's views. An "educator resources" section has also been created by ActionBioscience.org that includes additional links and an original class lesson for high school students through college undergraduates to accompany this report. Links can be accessed at the end of each author's comments or by scrolling to the bottom area of this web page.

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April 2002

Intelligent Design?

A special report reprinted from *Natural History* magazine

Introduction

Prepared by Richard Milner & Vittorio Maestro, senior editors of Natural History

Darwin's
evidence
convinced
scientists that
natural selection
can better
explain life's
complexity than
intelligent design
(ID).

The idea that an organism's complexity is evidence for the existence of a cosmic designer was advanced centuries before Charles Darwin was born. Its best-known exponent was English theologian William Paley, creator of the famous watchmaker analogy. If we find a pocket watch in a field, Paley wrote in 1802, we immediately infer that it was produced not by natural processes acting blindly but by a designing human intellect. Likewise, he reasoned, the natural world contains abundant evidence of a supernatural creator. The argument from design, as it is

known, prevailed as an explanation of the natural world until the publication of the *Origin of Species* in 1859. The weight of the evidence that Darwin had patiently gathered swiftly convinced scientists that evolution by natural selection better explained life's complexity and diversity. "I cannot possibly believe," wrote Darwin in 1868, "that a false theory would explain so many classes of facts."

ID proponents accept that some species do change and that Earth is much more than 6,000 years old but reject that evolution accounts for the array of species.

In some circles, however, opposition to the concept of evolution has persisted to the present. The argument from design has recently been revived by a number of academics with scientific credentials, who maintain that their version of the idea (unlike Paley's) is soundly supported by both microbiology and mathematics. These antievolutionists differ from fundamentalist creationists in that they accept that some species do change (but not much) and that Earth is much more than 6,000 years old. Like their predecessors, however, they reject the idea that evolution accounts for the array of species we see today, and they seek to have their concept -- known as intelligent design -- included in the science curriculum of schools.

ID is getting a hearing in some political and educational circles.

Most biologists have concluded that the proponents of intelligent design display either ignorance or deliberate misrepresentation of evolutionary science. Yet their proposals are getting a hearing in some political and educational circles and are currently the subject of a debate within the Ohio Board of Education. Although *Natural History* does not fully present and analyze the intelligent-design phenomenon in the pages that follow, we offer, for the reader's information, brief position statements by three leading proponents of the theory, along with three responses. The section concludes with an overview of the intelligent-design movement by a philosopher and cultural historian who has monitored its history for more than a decade.

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Intelligent Design position statement

The Challenge of Irreducible Complexity

Every living cell contains many ultrasophisticated molecular machines.

By Michael J. Behe

Black box: a system whose inner workings are unknown.

Scientists use the term "black box" for a system whose inner workings are unknown. To Charles Darwin and his contemporaries, the living cell was a black box because its fundamental mechanisms were completely obscure. We now know that, far from being formed from a kind of simple, uniform protoplasm (as many nineteenth-century scientists believed), every living cell contains many ultrasophisticated molecular machines.

Does natural selection account for complexity that exists at the molecular level?

How can we decide whether Darwinian natural selection can account for the amazing complexity that exists at the molecular level? Darwin himself set the standard when he acknowledged, "If it could be demonstrated that any complex organ existed which could not possibly have been formed by numerous, successive, slight modifications, my theory would absolutely break down."

Irreducibly complex systems: systems that seem very difficult to form by successive modifications.

Some systems seem very difficult to form by such successive modifications -- I call them irreducibly complex. An everyday example of an irreducibly complex system is the humble mousetrap. It consists of (1) a flat wooden platform or base; (2) a metal hammer, which crushes the mouse; (3) a spring with extended ends to power the hammer; (4) a catch that releases the spring; and (5) a metal bar that connects to the catch and holds the hammer back. You can't catch a mouse with just a platform, then add a spring and catch a few more mice, then add a holding bar and catch a few more. All the pieces have to be in place before you catch any mice.

Natural selection can only choose among systems that are already working so irreducibly complex biological systems pose a powerful challenge to Darwinian theory.

Irreducibly complex systems appear very unlikely to be produced by numerous, successive, slight modifications of prior systems, because any precursor that was missing a crucial part could not function. Natural selection can only choose among systems that are already working, so the existence in nature of irreducibly complex biological systems poses a powerful challenge to Darwinian theory. We frequently observe such systems in cell organelles, in which the removal of one element would cause the whole system to cease functioning. The flagella of bacteria are a good example. They are outboard motors that bacterial cells can use for self-propulsion. They have a long, whiplike propeller that is rotated by a molecular motor. The propeller is attached to the motor by a universal joint. The motor is held in place by proteins that act as a stator. Other proteins act as bushing material to allow the driveshaft to penetrate the bacterial membrane. Dozens of different kinds of proteins are necessary for a working flagellum. In the absence of almost any of them, the flagellum does not work or cannot even be built by the cell.

Constant, regulated traffic flow in cells is an example of a complex, irreducible system.

Another example of irreducible complexity is the system that allows proteins to reach the appropriate subcellular compartments. In the eukaryotic cell there are a number of places where specialized tasks, such as digestion of nutrients and excretion of wastes, take place. Proteins are synthesized outside these compartments and can reach their proper destinations only with the help of "signal" chemicals that turn other reactions on and off at the appropriate times. This constant, regulated traffic flow in the cell comprises another remarkably complex, irreducible system. All parts must function in synchrony or the system breaks down. Still another example is the exquisitely coordinated mechanism that causes blood to clot.

Molecular machines are designed.

Biochemistry textbooks and journal articles describe the workings of some of the many living molecular machines within our cells, but they offer very little information about how these systems supposedly evolved by natural selection. Many scientists frankly admit their bewilderment about how they may have originated, but refuse to entertain the obvious hypothesis: that perhaps molecular machines appear to look designed because they really *are* designed.

Advances in science provide new reasons for recognizing

I am hopeful that the scientific community will eventually admit the possibility of intelligent design, even if that acceptance is discreet and muted. My reason for optimism is the advance of science itself, which almost every day uncovers new intricacies in nature, fresh reasons for

design.

recognizing the design inherent in life and the universe.

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Evolution response to Michael J. Behe**The Flaw in the Mousetrap**

Intelligent design fails the biochemistry test.

By Kenneth R. Miller

Michael J. Behe fails to provide biochemical evidence for intelligent design.

To understand why the scientific community has been unimpressed by attempts to resurrect the so-called argument from design, one need look no further than Michael J. Behe's own essay. He argues that complex biochemical systems could not possibly have been produced by evolution because they possess a quality he calls irreducible complexity. Just like mousetraps, these systems cannot function unless each of their parts is in place. Since "natural selection can only choose among systems that are already working," there is no way that Darwinian mechanisms could have fashioned the complex systems found in living cells. And if such systems could not have evolved, they must have been designed. That is the totality of the biochemical "evidence" for intelligent design.

Parts of a supposedly irreducibly complex machine may have different, but still useful, functions.

Ironically, Behe's own example, the mousetrap, shows what's wrong with this idea. Take away two parts (the catch and the metal bar), and you may not have a mousetrap but you do have a three-part machine that makes a fully functional tie clip or paper clip. Take away the spring, and you have a two-part key chain. The catch of some mousetraps could be used as a fishhook, and the wooden base as a paperweight; useful applications of other parts include everything from toothpicks to nutcrackers and clipboard holders. The point, which science has long understood, is that bits and pieces of supposedly irreducibly complex machines may have different -- but still useful -- functions.

Evolution produces complex biochemical machines.

Behe's contention that each and every piece of a machine, mechanical or biochemical, must be assembled in its final form before anything useful can emerge is just plain wrong. Evolution produces complex biochemical machines by copying, modifying, and combining proteins previously used for other functions. Looking for examples? The systems in Behe's essay will do just fine.

Natural selection favors an organism's parts for different functions.

He writes that in the absence of "almost any" of its parts, the bacterial flagellum "does not work." But guess what? A small group of proteins from the flagellum *does work* without the rest of the machine -- it's used by many bacteria as a device for injecting poisons into other cells. Although the function performed by this small part when working alone is different, it nonetheless can be favored by natural selection.

The blood clotting system is an example of evolution.

The key proteins that clot blood fit this pattern, too. They're actually modified versions of proteins used in the digestive system. The elegant work of Russell Doolittle has shown how evolution duplicated, retargeted, and modified these proteins to produce the vertebrate blood-clotting system.

Working researchers see evolution in subcellular systems.

And Behe may throw up his hands and say that *he* cannot imagine how the components that move proteins between subcellular compartments could have evolved, but scientists actually working on such systems completely disagree. In a 1998 article in the journal *Cell*, a group led by James Rothman, of the Sloan-Kettering Institute, described the remarkable simplicity and uniformity of these mechanisms. They also noted that these mechanisms "suggest in a natural way how the many and diverse compartments in eukaryotic cells could have evolved in the first place." Working researchers, it seems, see something very different from what Behe sees in these systems -- they see evolution.

Behe's points are philosophical, not scientific.

If Behe wishes to suggest that the intricacies of nature, life, and the universe reveal a world of meaning and purpose consistent with a divine intelligence, his point is philosophical, not scientific. It is a philosophical point of view, incidentally, that I share. However, to support that view, one should not find it necessary to pretend that we know less than we really do about the evolution of living systems. In the final analysis, the biochemical hypothesis of intelligent design fails not because the scientific community is closed to it but rather for the most basic of reasons -- because it is overwhelmingly contradicted by the scientific evidence.

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Intelligent Design position statement

Detecting Design in the Natural Sciences

Intelligence leaves behind a characteristic signature.

By William A. Dembski

Chance, necessity, or design covers every eventuality in ordinary life.

In ordinary life, explanations that invoke chance, necessity, or design cover every eventuality. Nevertheless, in the natural sciences one of these modes of explanation is considered superfluous -- namely, design. From the perspective of the natural sciences, design, as the action of an intelligent agent, is not a fundamental creative force in nature. Rather, blind natural causes, characterized by chance and necessity and ruled by unbroken laws, are thought sufficient to do all nature's creating. Darwin's theory is a case in point.

Does nature require no help from a designing intelligence?

But how do we know that nature requires no help from a designing intelligence? Certainly, in special sciences ranging from forensics to archaeology to SETI (the Search for Extraterrestrial Intelligence), appeal to a designing intelligence is indispensable. What's more, within these sciences there are well-developed techniques for identifying intelligence. Essential to all these techniques is the ability to eliminate chance and necessity.

Complex, sequenced patterns exhibit intelligence in their design.

For instance, how do the radio astronomers in *Contact* (the Jodie Foster movie based on Carl Sagan's novel of the same name) infer the presence of extraterrestrial intelligence in the beeps and pauses they monitor from space? The researchers run signals through computers that are programmed to recognize many preset patterns. Signals that do not

match any of the patterns pass through the "sieve" and are classified as random. After years of receiving apparently meaningless "random" signals, the researchers discover a pattern of beats and pauses that corresponds to the sequence of all the prime numbers between 2 and 101. (Prime numbers, of course, are those that are divisible only by themselves and by one.) When a sequence begins with 2 beats, then a pause, 3 beats, then a pause . . . and continues all the way to 101 beats, the researchers must infer the presence of an extraterrestrial intelligence.

If a sequence lacks complexity, it could easily happen by chance.

Here's why. There's nothing in the laws of physics that requires radio signals to take one form or another. The sequence is therefore contingent rather than necessary. Also, it is a long sequence and therefore complex. Note that if the sequence lacked complexity, it could easily have happened by chance. Finally, it was not just complex but also exhibited an independently given pattern or specification (it was not just any old sequence of numbers but a mathematically significant one -- the prime numbers).

Specified complexity: the characteristic trademark or signature of intelligence.

Intelligence leaves behind a characteristic trademark or signature -- what I call "specified complexity." An event exhibits specified complexity if it is contingent and therefore not necessary; if it is complex and therefore not easily repeatable by chance; and if it is specified in the sense of exhibiting an independently given pattern. Note that complexity in the sense of improbability is not sufficient to eliminate chance: flip a coin long enough, and you'll witness a highly complex or improbable event. Even so, you'll have no reason not to attribute it to chance.

Specifications must be objectively given.

The important thing about specifications is that they be objectively given and not just imposed on events after the fact. For instance, if an archer shoots arrows into a wall and we then paint bull's-eyes around them, we impose a pattern after the fact. On the other hand, if the targets are set up in advance ("specified") and then the archer hits them accurately, we know it was by design.

Undirected natural processes are incapable of generating the specified complexity in organisms.

In my book *The Design Inference*, I argue that specified complexity reliably detects design. In that book, however, I focus largely on examples from the human rather than the natural sciences. The main criticism of that work to date concerns whether the Darwinian mechanism of natural selection and random variation is not in fact fully capable of generating specified complexity. More recently, in *No Free Lunch*, I show that undirected natural processes like the Darwinian mechanism are incapable of generating the specified complexity that exists in biological organisms. It follows that chance and necessity are insufficient for the natural sciences and that the natural sciences need to leave room for design.

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Evolution response to William A. Dembski

Mystery Science Theater

The case of the secret agent.

By Robert T. Pennock

Science requires positive evidence that biological complexity is intentionally designed.

William A. Dembski claims to detect "specified complexity" in living things and argues that it is proof that species have been designed by an intelligent agent. One flaw in his argument is that he wants to define intelligent design negatively, as anything that is not chance or necessity. But the definition is rigged: necessity, chance, and design are not mutually exclusive categories, nor do they exhaust the possibilities. Thus, one cannot detect an intelligent agent by the process of elimination he suggests. Science requires positive evidence. This is so even when attempting to detect the imprint of human intelligence, but it is especially true when assessing the extraordinary claim that biological complexity is intentionally designed.

William A. Dembski has no way to show that genetic patterns are set up in advance.

In this regard, Dembski's archery and SETI analogies are red herrings, for they tacitly depend on prior understanding of human intellect and motivation, as well as of relevant causal processes. A design inference like that in the movie *Contact*, for instance, would rely on background knowledge about the nature of radio signals and other natural processes, together with the assumption that a sequence of prime numbers is the kind of pattern another scientist might choose to send as a signal. But the odd sequences found within DNA are quite unlike a series of prime numbers. Dembski has no way to show that the genetic patterns are "set up in advance" or "independently given."

Antievolutionists claim that evolution violates the second law of thermodynamics, but this misunderstands how the law applies to biological systems.

Dembski has been promoted as "the Isaac Newton of information theory," and in his writings, which include the books he cites in the essay here, he insists that his "law of conservation of information" proves that natural processes cannot increase biological complexity. He doesn't lay out his case here, and a refutation would require too much space. Suffice it to say that a connection exists between the technical notion of information and that of entropy, so Dembski's argument boils down to a recasting of an old creationist claim that evolution violates the second law of thermodynamics. Put simply, this law states that in the universe, there is a tendency for complexity to decrease. How then, ask the creationists, can evolutionary processes produce more complex life-forms from more primitive ones? But we have long known why this type of argument fails: the second law applies only to closed systems, and biological systems are not closed.

Random genetic variation is subjected to natural selection by the environment.

In the evolutionary process, an increase in biological complexity does not represent a "free lunch" -- it is bought and paid for, because random genetic variation is subjected to natural selection by the environment, which itself is already structured. In fact, researchers are beginning to use Darwinian processes, implemented in computers or in vitro, to evolve complex systems and to provide solutions to design problems in ways that are beyond the power of mere intelligent agents.

Dembski's hypothesis of design provides precious little that is testable.

If we really thought that genetic information was like the signal in *Contact*, shouldn't we infer we were designed by extraterrestrials? Intelligent-design theorists do sometimes mention extraterrestrials as possible suspects, but most seem to have their eyes on a designer more highly placed in the heavens. The problem is, science requires a specific

model that can be tested. What exactly did the designer do, and when did he do it? Dembski's nebulous hypothesis of design, even if restricted to natural processes, provides precious little that is testable, and once supernatural processes are wedged in, it loses any chance of testability.

Darwin followed the clues given in nature to solve the mystery of origins.

Newton found himself stymied by the complex orbits of the planets. He could not think of a natural way to fully account for their order and concluded that God must nudge the planets into place to make the system work. (So perhaps in this one sense, Dembski *is* the Newton of information theory.) The origin of species once seemed equally mysterious, but Darwin followed the clues given in nature to solve that mystery. One may, of course, retain religious faith in a designer who transcends natural processes, but there is no way to dust for his fingerprints.

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Intelligent Design position statement

Elusive Icons of Evolution

What do Darwin's finches and the four-winged fruit fly really tell us?

By Jonathan Wells

Many features of living things appear to be designed.

Charles Darwin wrote in 1860 that "there seems to be no more design in the variability of organic beings and in the action of natural selection, than in the course which the wind blows." Although many features of living things appear to be designed, Darwin's theory was that they are actually the result of undirected processes such as natural selection and random variation.

Darwin's finches are one of the "icons of evolution."

Scientific theories, however, must fit the evidence. Two examples of the evidence for Darwin's theory of evolution -- so widely used that I have called them "icons of evolution" -- are Darwin's finches and the four-winged fruit fly. Yet both of these, it seems to me, show that Darwin's theory cannot account for all features of living things.

Finch beaks appear to be adapted to different foods through natural selection.

Darwin's finches consist of several species on the Galápagos Islands that differ mainly in the size and shape of their beaks. Beak differences are correlated with what the birds eat, suggesting that the various species might have descended from a common ancestor by adapting to different foods through natural selection. In the 1970s, biologists Peter and Rosemary Grant went to the Galápagos to observe this process in the wild.

Direct evidence for this was found in the 1970s.

In 1977 the Grants watched as a severe drought wiped out 85 percent of a particular species on one island. The survivors had, on average, slightly larger beaks that enabled them to crack the tough seeds that had endured the drought. This was natural selection in action. The Grants estimated that twenty such episodes could increase average beak size enough to produce a new species.

Modern scientists did not observe new species

When the rains returned, however, average beak size returned to normal. Ever since, beak size has oscillated around a mean as the food

emerging.

supply has fluctuated with the climate. There has been no net change, and no new species have emerged. In fact, the opposite may be happening, as several species of Galápagos finches now appear to be merging through hybridization.

Natural selection works only within established species.

Darwin's finches and many other organisms provide evidence that natural selection can modify existing features -- but only within established species. Breeders of domestic plants and animals have been doing the same thing with artificial selection for centuries. But where is the evidence that selection produces *new* features in *new* species?

Major evolutionary changes require anatomical as well as biochemical changes.

New features require new variations. In the modern version of Darwin's theory, these come from DNA mutations. Most DNA mutations are harmful and are thus eliminated by natural selection. A few, however, are advantageous -- such as mutations that increase antibiotic resistance in bacteria and pesticide resistance in plants and animals. Antibiotic and pesticide resistance are often cited as evidence that DNA mutations provide the raw materials for evolution, but they affect only chemical processes. Major evolutionary changes would require mutations that produce advantageous *anatomical* changes as well.

The four-winged fruit fly is another "icon of evolution."

Normal fruit flies have two wings and two "balancers" -- tiny structures behind the wings that help stabilize the insect in flight. In the 1970s, geneticists discovered that a combination of three mutations in a single gene produces flies in which the balancers develop into normal-looking wings. The resulting four-winged fruit fly is sometimes used to illustrate how mutations can produce the sorts of anatomical changes that Darwin's theory needs.

This fly does not provide evidence for evolution.

But the extra wings are not new structures, only duplications of existing ones. Furthermore, the extra wings lack muscles and are therefore worse than useless. The four-winged fruit fly is severely handicapped -- like a small plane with extra wings dangling from its tail. As is the case with all other anatomical mutations studied so far, those in the four-winged fruit fly cannot provide raw materials for evolution.

Intelligent design should be taught in school.

In the absence of evidence that natural selection and random variations can account for the apparently designed features of living things, the entire question of design must be reopened. Alongside Darwin's argument against design, students should also be taught that design remains a possibility.

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Evolution response to Jonathan Wells**The Nature of Change**

Evolutionary mechanisms give rise to basic structural differences.

By Eugenie C. Scott

Darwin proposed a scientific rather than a religious explanation of nature.

Without defining "design," Wells asserts that "many features of living things appear to be designed." Then he contrasts natural selection (undirected) with design (directed), apparently attempting to return to the pre-Darwinian notion that a Designer is directly responsible for the

fit of organisms to their environments. Darwin proposed a scientific rather than a religious explanation: the fit between organisms and environments is the result of natural selection. Like all scientific explanations, his relies on natural causation.

Modern science can now draw on evidence from biological processes.

Wells contends that "Darwin's theory cannot account for all features of living things," but then, it doesn't have to. Today scientists explain features of living things by invoking not only natural selection but also additional biological processes that Darwin didn't know about, including gene transfer, symbiosis, chromosomal rearrangement, and the action of regulator genes. Contrary to what Wells maintains, evolutionary theory is not inadequate. It fits the evidence just fine.

Darwin's conclusion that Galapagos finches had a common ancestor is confirmed by modern genetic analysis.

Reading Wells, one might not realize the importance of the Grants' careful studies, which demonstrated natural selection in real time. That the drought conditions abated before biologists witnessed the emergence of new species is hardly relevant; beak size does oscillate in the short term, but given a long-term trend in climate change, a major change in average size can be expected. Wells also overstates the importance of finch hybridization: it is extremely rare, and it might even be contributing to new speciation. The Galapagos finches remain a marvelous example of the principle of adaptive radiation. The various species, which differ morphologically, occupy different adaptive niches. Darwin's explanation was that they all evolved from a common ancestral species, and modern genetic analysis provides confirming evidence.

The discovery of Ubx genes shed light on how body plans evolve.

Wells admits that natural selection can operate on a population and correctly looks to genetics to account for the kind of variation that can lead to "new features in new species." But he contends that mutations such as those that yield four-winged fruit flies do not produce the sorts of anatomical changes needed for major evolutionary change. Can't he see past the example to the principle? That the first demonstration of a powerful genetic mechanism happened to be a nonflying fly is irrelevant. Edward Lewis shared a Nobel Prize for the discovery of the role of these genes, known as the *Ubx* complex. They are of extraordinary importance because genes of this type help explain body plans -- the basic structural differences between a mollusk and a mosquito, a sponge and a spider.

A very small Ubx change results in a big difference in the body plan of organisms.

Ubx genes are among the *HOX* genes, found in animals as different as sponges, fruit flies, and mammals. They turn on or off the genes involved in -- among other things -- body segmentation and the production of appendages such as antennae, legs, and wings. What specifically gets built depends on other, downstream genes. The diverse body plans of arthropods (insects, crustaceans, arachnids) are variations on segmentation and appendage themes, variations that appear to be the result of changes in *HOX* genes. Recent research shows that fly *Ubx* genes suppress leg formation in abdominal segments but that crustacean *Ubx* genes don't; a very small *Ubx* change results in a big difference in body plan.

These genes allow for anatomical experimentation.

Mutations in these primary on/off switches are involved in such phenomena as the loss of legs in snakes, the change from lobe fins to hands, and the origin of jaws in vertebrates. *HOX*-initiated segment

duplication allows for anatomical experimentation, and natural selection winnows the result. "Evo-Devo" -- the study of evolution and development -- is a hot new biological research area, but Wells implies that all it has produced is crippled fruit flies.

Science only has tools for explaining things in terms of natural causes.

Wells argues that natural explanations are inadequate and, thus, that "students should also be taught that design remains a possibility." Because in his logic, design implies a Designer, he is in effect recommending that science allow for nonnatural causation. We actually do have solid natural explanations to work with, but even if we didn't, science only has tools for explaining things in terms of natural causation. That's what Darwin did, and that's what we're trying to do today.

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Overview

The Newest Evolution of Creationism

Intelligent design is about politics and religion, not science.

By Barbara Forrest

Intelligent Design (ID) proponents put most of their effort in swaying politicians and the public.

The infamous August 1999 decision by the Kansas Board of Education to delete references to evolution from Kansas science standards was heavily influenced by advocates of intelligent-design theory. Although William A. Dembski, one of the movement's leading figures, asserts that "the empirical detectability of intelligent causes renders intelligent design a fully scientific theory," its proponents invest most of their efforts in swaying politicians and the public, not the scientific community.

The leading ID organization is the Center for the Renewal of Science and Culture (CRSC).

Launched by Phillip E. Johnson's book *Darwin on Trial* (1991), the intelligent-design movement crystallized in 1996 as the Center for the Renewal of Science and Culture (CRSC), sponsored by the Discovery Institute, a conservative Seattle think tank. Johnson, a law professor whose religious conversion catalyzed his antievolution efforts, assembled a group of supporters who promote design theory through their writings, financed by CRSC fellowships. According to an early mission statement, the CRSC seeks "nothing less than the overthrow of materialism and its damning cultural legacies."

The CRSC calls its strategy the "Wedge," because it wants to liberate science from "atheistic naturalism."

Johnson refers to the CRSC members and their strategy as the Wedge, analogous to a wedge that splits a log -- meaning that intelligent design will liberate science from the grip of "atheistic naturalism." Ten years of Wedge history reveal its most salient features: Wedge scientists have no empirical research program and, consequently, have published no data in peer-reviewed journals (or elsewhere) to support their intelligent-design claims. But they do have an aggressive public relations program, which includes conferences that they or their supporters organize, popular books and articles, recruitment of students through university lectures sponsored by campus ministries, and cultivation of alliances with conservative Christians and influential political figures.

Philip E. Johnson:
*"This isn't really,
 and never has
 been, a debate
 about science.
 It's about religion
 and philosophy."*

The Wedge aims to "renew" American culture by grounding society's major institutions, especially education, in evangelical religion. In 1996, Johnson declared: "This isn't really, and never has been, a debate about science. It's about religion and philosophy." According to Dembski, intelligent design "is just the Logos of John's Gospel restated in the idiom of information theory." Wedge strategists seek to unify Christians through a shared belief in "mere" creation, aiming -- in Dembski's words -- "at defeating naturalism and its consequences." This enables intelligent-design proponents to coexist in a big tent with other creationists who explicitly base their beliefs on a literal interpretation of Genesis.

**At heart, ID
 proponents are
 not motivated to
 improve science
 but to transform
 it into a theistic
 enterprise.**

"As Christians," writes Dembski, "we know naturalism is false. Nature is not self-sufficient. ... Nonetheless neither theology nor philosophy can answer the evidential question whether God's interaction with the world is empirically detectable. To answer this question we must look to science." Jonathan Wells, a biologist, and Michael J. Behe, a biochemist, seem just the CRSC fellows to give intelligent design the ticket to credibility. Yet neither has actually done research to test the theory, much less produced data that challenges the massive evidence accumulated by biologists, geologists, and other evolutionary scientists. Wells, influenced in part by Unification Church leader Sun Myung Moon, earned Ph.D.'s in religious studies and biology specifically "to devote my life to destroying Darwinism." Behe sees the relevant question as whether "science can make room for religion." At heart, proponents of intelligent design are not motivated to improve science but to transform it into a theistic enterprise that supports religious faith.

**The ID
 movement is
 advancing its
 strategy but its
 tactics are no
 substitute for
 real science.**

Wedge supporters are at present trying to insert intelligent design into Ohio public-school science standards through state legislation. Earlier the CRSC advertised its science education site by assuring teachers that its "Web curriculum can be appropriated without textbook adoption wars" -- in effect encouraging teachers to do an end run around standard procedures. Anticipating a test case, the Wedge published in the *Utah Law Review* a legal strategy for winning judicial sanction. Recently the group almost succeeded in inserting into the federal No Child Left Behind Act of 2001 a "sense of the Senate" that supported the teaching of intelligent design. So the movement is advancing, but its tactics are no substitute for real science.

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Richard Milner and Vittorio Maestro are senior editors of *Natural History* magazine. *Natural History* is published by The American Museum of Natural History. The museum was created in 1869 in New York City, U.S.A. and the magazine was established in 1900. <http://www.naturalhistorymag.com>

Michael J. Behe, who received his Ph.D. in biochemistry from the University of Pennsylvania in 1978, is a professor of biological sciences at Pennsylvania's Lehigh University. His current research involves the roles of design and natural selection in building protein structure. His book *Darwin's Black Box: The Biochemical Challenge to Evolution* is available in paperback (Touchstone Books, 1998). <http://www.lehigh.edu/%7einbios/faculty/behe.html>

Kenneth R. Miller is a professor of biology at Brown University. His research work on cell membrane structure and function has been reported in such journals as *Nature*, *Cell*, and the *Journal of Cell Biology*. Miller is co-author of several widely used high school and college biology textbooks, and in 1999 he published *Finding Darwin's God: A Scientist's Search for Common Ground Between God and Evolution* (Cliff Street Books). <http://bms.brown.edu/faculty/m/kmiller/>

William A. Dembski, who holds Ph.D.'s in mathematics and philosophy, is an associate research professor at Baylor University and a senior fellow with the Discovery Institute in Seattle. His books include *The Design Inference: Eliminating Chance Through Small Probabilities* (Cambridge University Press, 1998) and *No Free Lunch: Why Specified Complexity Cannot Be Purchased Without Intelligence* (Rowman and Littlefield, 2001). <http://www.designinference.com/>

Robert T. Pennock is an associate professor of science and technology studies and associate professor of philosophy in Michigan State University's Lyman Briggs School and department of philosophy. He is the author of *Tower of Babel: The Evidence Against the New Creationism* (MIT Press, 1999) and editor of *Intelligent Design Creationism and Its Critics: Philosophical, Theological, and Scientific Perspectives* (MIT Press, 2001). <http://www.msu.edu/~pennock5/>

Jonathan Wells received two Ph.D.'s, one in molecular and cell biology from the University of California, Berkeley, and one in religious studies from Yale University. He has worked as a postdoctoral research biologist at the University of California, Berkeley, and has taught biology at California State University, Hayward. Wells is also the author of *Icons of Evolution: Science or Myth? Why Much of What We Teach About Evolution Is Wrong* (Regnery Publishing, 2000). <http://www.arn.org/wells/jwhome.htm>

Eugenie C. Scott holds a Ph.D. in physical anthropology. In 1987, after teaching physical anthropology at the university level for fifteen years, she became executive director of the National Center for Science Education. She is currently also the president of the American Association of Physical Anthropologists. http://en.wikipedia.org/wiki/Eugenie_Scott

Barbara Forrest is an associate professor of philosophy at Southeastern Louisiana University. She received her Ph.D. from Tulane University. Her recent scholarly publications include "The Possibility of Meaning in Human Evolution," *Zygon: Journal of Religion and Science*, Dec. 2000. http://www.selu.edu/Academics/ArtsSciences/CAS_Endowed%20Chairs/doc/dr_forrest.html

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Suggested links

» *Natural History*

This magazine of nature, science, and culture, from The American Museum of Natural History, publishes articles about the environment, humanity, biodiversity, and the cosmos.

<http://www.naturalhistorymag.com>

» Darwin online

The Origin of Species: By Means of Natural Selection or the Preservation of Favored Races in the Struggle for Life, Charles Darwin's classic, written in 1859, is the monumental work that influenced the theory of evolution (Modern Library, 1993 reissue). It can be read in its entirety online at:

<http://www.literature.org/authors/darwin-charles/the-origin-of-species/>

Links recommended by Michael J. Behe, Ph.D.

» Center for the Renewal of Science and Culture

Discovery Institute presents information and articles about intelligent design.

<http://www.crsc.org>

» Access Research Network

Access Research Network is a "non-profit organization dedicated to providing accessible information on science, technology and society" from an intelligent-design perspective.

<http://www.arn.org>

» Intelligent Design Undergraduate Research Community

This intelligent design web site is a division of Access Research Network. It features articles, discussion, and educational information.

<http://www.idurc.org>

» International Society for Complexity, Information, and Design (ISCID)

ISCID is "a cross-disciplinary professional society that investigates complex systems apart from external programmatic constraints like materialism, naturalism, or reductionism."

<http://www.iscid.org>

Links recommended by Kenneth R. Miller, Ph.D.

» "Behe's Empty Box"

Extensive material dealing with the flaws of Michael J. Behe's argument about "irreducible complexity."

<http://www.simonyi.ox.ac.uk/dawkins/WorldOfDawkins-archive/Catalano/box/behe.shtml>

» Brown University evolution resources

Additional resources on the intelligent design issue and calendar of talks on evolution on Kenneth R. Miller's evolution web page at Brown University.

<http://www.millerandlevine.com/km/evol/>

» "Design on the Defensive"

Kenneth R. Miller responds to Michael Behe's ideas about design. Includes links.

<http://www.millerandlevine.com/km/evol/DI/Design.html>

Links recommended by William A. Dembski, Ph.D.

» International Society for Complexity, Information, and Design (ISCID)

ISCID's "aim is to pursue the theoretical development, empirical application, and philosophical implications of information and design-theoretic concepts for complex systems."

<http://www.iscid.org/>

» Articles by William A. Dembski

Many articles by the author to choose from on the Discovery Institute site.

<http://www.discovery.org/scripts/viewDB/index.php?command=view&id=32&isFellow=true>

Links recommended by Robert T. Pennock, Ph.D.

» *Tower of Babel: The Evidence Against the New Creationism*

Robert T. Pennock's book criticizes the arguments of intelligent design theory. This link downloads a PDF file of the first chapter, which discusses the relationship of intelligent design to other kinds of creationism.

<http://mitpress.mit.edu/books/PENOH/ch01.pdf>

» Articles and books by Robert T. Pennock

Information on other publications by the author that analyzes intelligent design, including his anthology *Intelligent Design Creationism and Its Critics: Philosophical, Theological and Scientific Perspectives* which collects key articles by ID leaders together with critical responses.

<http://www.msu.edu/~pennock5/research/publications.html>

» Michigan Citizens for Science

Provides information to "promote quality science education in Michigan," and to defend against attempts to insert intelligent design in the curriculum.

<http://www.michigancitizensforscience.org>

Links recommended by Jonathan Wells, Ph.D.

» *Icons of Evolution*

This site promotes the book *Icons of Evolution* by Jonathan Wells. You can read the book's intro online and get linked to articles by the author.

<http://www.iconsofevolution.com/>

» Discovery Institute: Articles by Jonathan Wells

Click on "articles by Jonathan Wells" on the author's bio page for more of his views on intelligent design.

<http://www.discovery.org/scripts/viewDB/index.php?command=view&isFellow=true&id=41>

» "Inherit the Spin" article

Jonathan Wells responds to the National Center for Science Education's advice to students and teachers about evolution.

<http://www.discovery.org/viewDB/index.php3?program=CRSC%20Responses&command=view&id=1106>

Links recommended by Eugenie Scott, Ph.D.

» National Center for Science Education (NCSE)

Nonprofit membership organization NCSE is "a nationally-recognized clearinghouse for information and advice to keep evolution in the science classroom and 'scientific creationism' out." The first link takes you to its home page; the second to Eugenie Scott's review of Robert T. Pennock's book *Tower of Babel: The Evidence Against the New Creationism*.

<http://www.natcensci.org/>

http://www.ncseweb.org/resources/articles/8269_creationism_evolves_review_of_3_16_2001.asp

» "Antievolution: The Critic's Resource"

This site "is for the critical examination of the antievolution movement. ...aims to provide links to both the antievolutionists making their own arguments and also to the critics who provide mainstream science answers to those arguments." The first link is to the home page and the second link is to an examination and critique of Jonathan Wells' views.

<http://www.antievolution.org/>

http://www.antievolution.org/people/wells_j/

» "Talk Origins: Exploring the Creation/Evolution Controversy"

This site is "devoted to the discussion and debate of biological and physical origins." The first link takes you to numerous links examining Michael J. Behe's hypothesis of "irreducible complexity." The second link is a chapter-by-chapter critique of Jonathan Wells' book *Icons of Evolution*.

<http://www.talkorigins.org/faqs/behe.html>

<http://www.talkorigins.org/faqs/wells/>

» Review of *Icons of Evolution*

Massimo Pigliucci, Ph.D., provides a critical review of Jonathan Wells' book and provides suggestions on how education should be improved so that students can understand the controversy better.

<http://chem.tufts.edu/AnswersInScience//Pigliucci-IconsReview.html>

Links recommended by Barbara Forrest, Ph.D.

» Kenneth R. Miller and Philip E. Johnson debate

NOVA Online asked two leading spokesmen in the evolution/creation debate to discuss the question, "How did we get here?"

<http://www.pbs.org/wgbh/nova/odyssey/debate/>

» Jonathan Wells and the Unification Church

In a Unification Church sermon, Wells speaks about the purpose of obtaining his graduate degree in science -- "devote my life to destroying Darwinism."

<http://www.tparents.org/library/unification/talks/wells/DARWIN.htm>

» "The Creation/Evolution Continuum" article

A historical overview, by Eugenie Scott, explaining the range of creationist views (12/00).

http://www.natcensci.org/resources/articles/1593_the_creationevolution_continu_12_7_2000.asp

» Intelligent Design and the cosmos

A professor of physics & astronomy examines and answers arguments from design.

<http://www.talkorigins.org/faqs/cosmo.html>

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ActionBioscience.org original lesson

This lesson has been written by a science educator to specifically accompany the above report. It includes report content and extension questions, as well as activity handouts for different grade levels.

Lesson Title: *Our Universe: Designed or Evolved?*

Levels: high school - undergraduate

Summary: This lesson investigates and compares two views -- Intelligent Design and Evolution. Student teams analyze and discuss viewpoints as paired in the online report, e.g., Behe and Miller. They can also evaluate web sites, create their own web page, speculate on complex biological systems... and more!



Download/view lesson, click icon:

(To open the lesson's PDF file, you need [Adobe Acrobat Reader](#) free software.)

Useful links/resources for educators

» National Association of Biology Teachers (NABT)

NABT's current "Position Statement On Teaching Evolution" is presented.

<http://www.nabt.org/sites/S1/index.php?p=65>

» *Evolution*

This PBS site provides supplemental material to each of the seven episodes of the *Evolution* television series (9/01). Also available are video, web activities, lab activities, and teaching resources related to evolution.

<http://www.pbs.org/wgbh/evolution>

» *Triumph of Life*

This PBS site is based on the six-part miniseries *Triumph of Life* (1/01) presented as part of the *Nature* series. The series describes the history of life on Earth and the best scientifically understood mechanisms for its current diversity. An evolutionary timeline and other

web-based instructional resources are provided. A teacher's guide in PDF format is available for download.

<http://www.pbs.org/wnet/nature/triumphoflife>

» *Contact*, the movie

If you have the DVD version of the movie *Contact* available, then you may wish to view the specific scenes (Scenes #11 "A signal" to #13 "Message in German") described by Dr. Dembski before discussing his views with your class.

» Understanding Evolution

Contains an extensive section especially for teachers, giving advice on teaching evolution, lesson plans, ways to avoid confusing students, and answering common student questions. From the University of California Museum of Paleontology and the National Center for Science Education.

<http://evolution.berkeley.edu>

Useful links for student research

Note: In addition, each author in the "Intelligent Design?" article has suggested links. They are found in the "learn more" section above.

» Botanical Society of America's Statement on Evolution

A clear explanation of evolution as a scientific theory is given. This is contrasted with the ideas of Intelligent Design/Creationism.

<http://www.botany.org/newsite/announcements/evolution.php>

» Evolution Website: BBC

This 1998 site includes the full text of Darwin's *Origin of Species* and an illustrated guide to the book. There are essays on Darwin and Darwinism for beginners to experts. Also included is the transcript of a question & answer session and a "Darwin Debate" with a panel of experts.

<http://www.bbc.co.uk/education/darwin>

» Evolution Update: Research Center for Students and Teachers of Biology

An extensive resource site, including links to "major news and scientific reports in evolutionary biology" and "web sites by topic."

<http://www.pageup.info/evolution/>

» Creation vs. Evolution

This message board also includes links to "mainstream science press" as well as "advocacy sites" dealing with Creation Science and Intelligent Design.

<http://crevo.bestmessageboard.com/>

» Creation Science


The website for the Institute for Creation Research, a self-described "Christ-focused Creation Ministry."

<http://www.icr.org>

» Intelligent Design

The website for the Access Research Network offers articles and educational materials from an Intelligent Design viewpoint.

<http://www.arn.org>

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