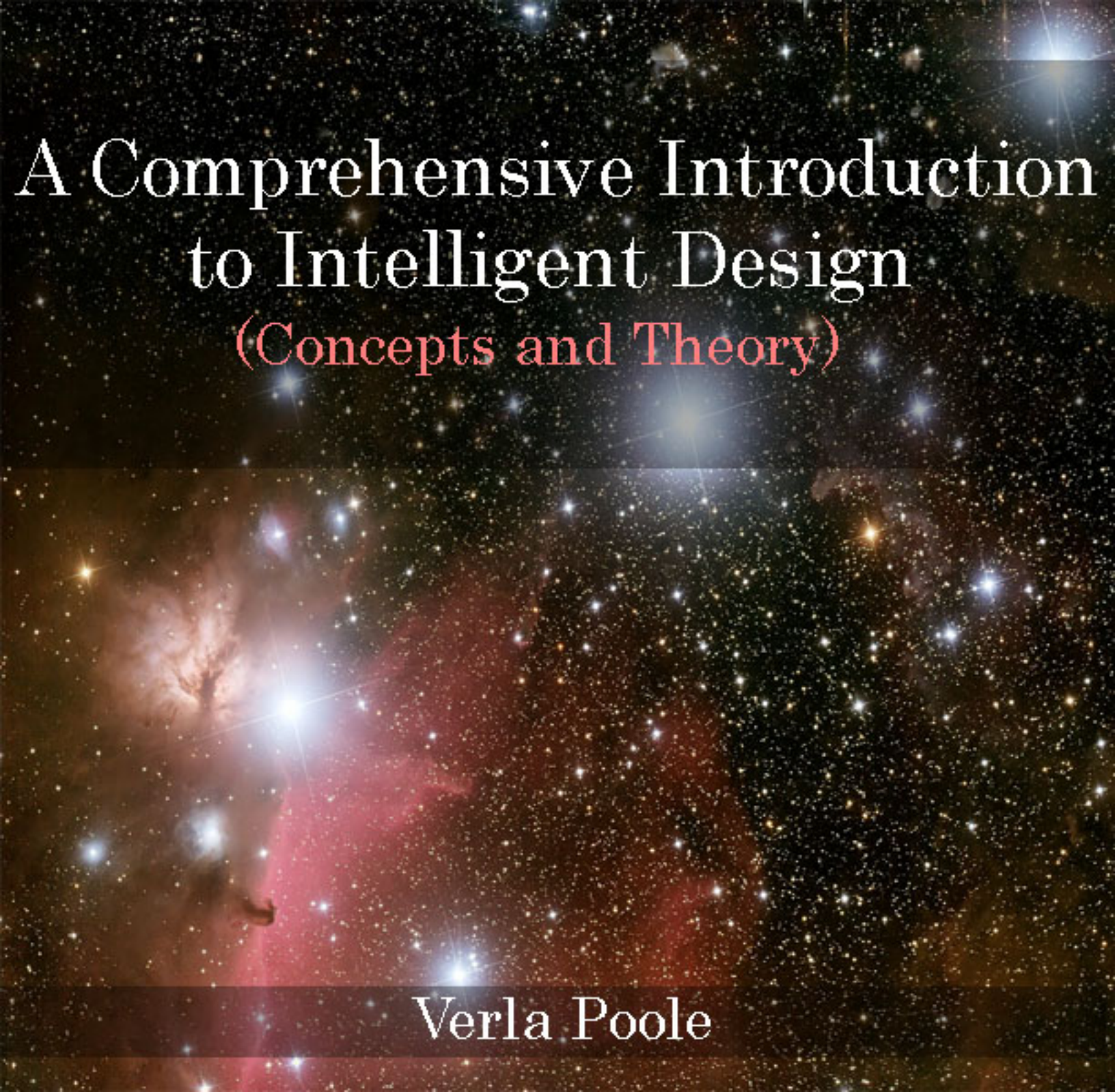
A Comprehensive Introduction to Intelligent Design
(Concepts and Theory)
Verla Poole

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Intelligent Design

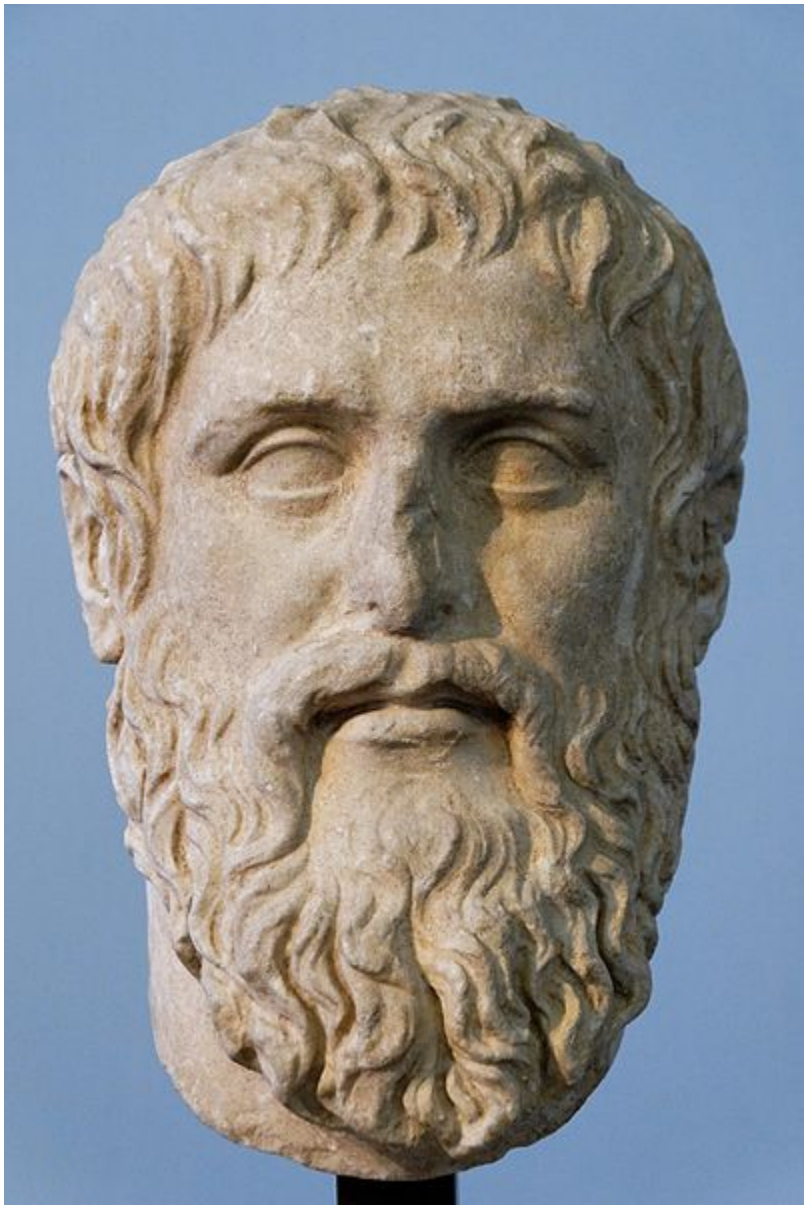
Intelligent design is the proposition that "certain features of the universe and of living things are best explained by an intelligent cause, not an undirected process such as natural selection." It is a form of creationism and a contemporary adaptation of the traditional teleological argument for the existence of God, but one that deliberately avoids specifying the nature or identity of the designer. Its leading proponents—all of whom are associated with the Discovery Institute, a politically conservative think tank—believe the designer to be the God of Christianity.

Proponents argue that intelligent design is a scientific theory. In so doing, they seek to fundamentally redefine science to include supernatural explanations. The overwhelming consensus in the scientific community is that intelligent design is not science, and indeed is pseudoscience.

Intelligent design was developed by a group of American creationists who revised their argument in the creation–evolution controversy to circumvent court rulings such as the United States Supreme Court *Edwards v. Aguillard* ruling, which barred the teaching of "creation science" in public schools as breaching the separation of church and state. The first significant published use of intelligent design was in *Of Pandas and People*, a 1989 textbook intended for high-school biology classes. From the mid-1990s, intelligent design proponents were supported by the Discovery Institute which, together with its Center for Science and Culture, planned and funded the "intelligent design movement". They advocated inclusion of intelligent design in public school curricula, leading to the 2005 *Kitzmiller v. Dover Area School District* trial, where U.S. District Judge John E. Jones III ruled that intelligent design is not science, that it "cannot uncouple itself from its creationist, and thus religious, antecedents", and that the school district's promotion of it therefore violated the Establishment Clause of the First Amendment to the U.S. Constitution.

History

Origin of the concept



A marble bust based on a portrait ca. 370 BC of Plato. The teleological argument, or "argument from design", is an ancient one, held in some form by Plato and Aristotle.

Whether the order and complexity of nature indicates purposeful design has been the subject of debate since the Greeks. In the 4th century BCE, Plato posited a good and wise "demiurge" as the creator and first cause of the cosmos in his *Timaeus.* In his *Metaphysics*, Aristotle developed the idea of an "Unmoved Mover". In *De Natura Deorum* (*On the Nature of the Gods*, 45 BCE) Cicero wrote that "the divine power is to

be found in a principle of reason which pervades the whole of nature." This line of reasoning has come to be known as the teleological argument for the existence of God. Some well-known forms of it were expressed in the 13th century by Thomas Aquinas and in the 19th century by William Paley. Aquinas, in his *Summa Theologiae*, used the concept of design in his "fifth proof" for God's existence.

In the early 19th century, Paley's argument from design in *Natural Theology* (1802), used the watchmaker analogy, and such arguments led to the development of what was called natural theology, the study of nature as way of understanding "the mind of God". This movement fueled the passion for collecting fossils and other biological specimens, which ultimately led to Charles Darwin's *On the Origin of Species* (1859). Similar reasoning postulating a divine designer is embraced today by many believers in theistic evolution, who consider modern science and the theory of evolution to be compatible with the concept of a supernatural designer. In correspondence about the question with Asa Gray, Darwin wrote that "I cannot honestly go as far as you do about Design. I am conscious that I am in an utterly hopeless muddle. I cannot think that the world, as we see it, is the result of chance; & yet I cannot look at each separate thing as the result of Design." Though he had studied Paley's work while at university, by the end of his life he came to regard it as useless for scientific development.

Intelligent design in the late 20th and early 21st century is a development of natural theology that seeks to change the basis of science and undermine evolutionary theory. As evolutionary theory expanded to explain more phenomena, the examples held up as evidence of design changed, though the essential argument remains the same: complex systems imply a designer. Past examples have included the eye and the feathered wing; current examples are typically biochemical: protein functions, blood clotting, and bacterial flagella; see irreducible complexity.

Philosopher Barbara Forrest writes that the intelligent design movement began in 1984 with the publication by Jon A. Buell's the Foundation for Thought and Ethics of *The Mystery of Life's Origin* by Charles B. Thaxton, a chemist and creationist. Thaxton held a conference in 1988, "Sources of Information Content in DNA," which attracted creationists such as Stephen C. Meyer. Forrest writes that, in December 1988, Thaxton decided to use the term "intelligent design," instead of creationism, for the movement.

In March 1986 a review by Meyer used information theory to suggest that messages transmitted by DNA in the cell show "specified complexity" specified by intelligence, and must have originated with an intelligent agent. In November of that year Thaxton described his reasoning as a more sophisticated form of Paley's argument from design. At the *Sources of Information Content in DNA* conference in 1988 he said that his intelligent cause view was compatible with both metaphysical naturalism and supernaturalism,

Intelligent design avoids identifying or naming the agent of creation—it merely states that one (or more) must exist—but leaders of the movement have said the designer is the Christian God. Whether this lack of specificity about the designer's identity in public discussions is a genuine feature of the concept, or just a posture taken to avoid alienating

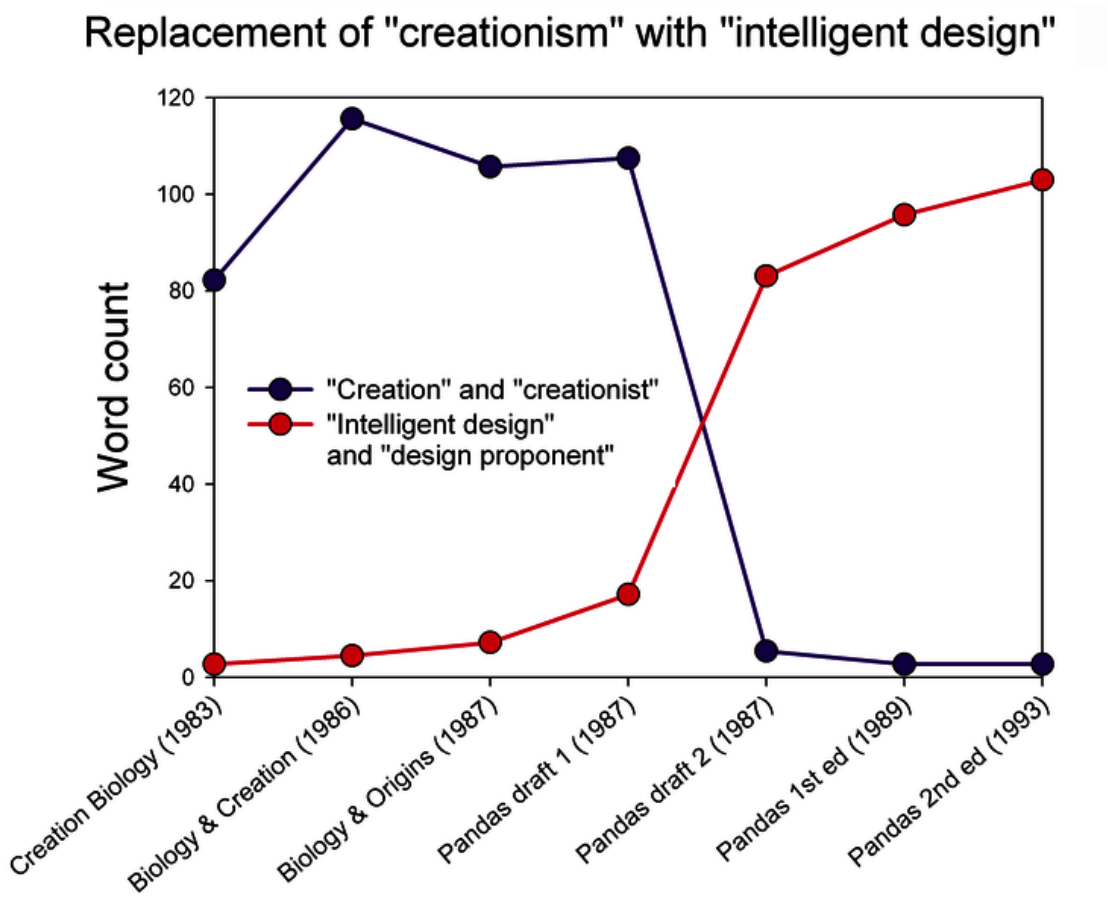
those who would separate religion from the teaching of science, has been a matter of great debate between supporters and critics of intelligent design. The *Kitzmiller v. Dover Area School District* court ruling held the latter to be the case.

Origin of the term

The phrase "intelligent design" can be found in an 1847 issue of *Scientific American*, in an 1850 book by Patrick Edward Dove, and in an 1861 letter from Charles Darwin. The Paleyite botanist George James Allman used the phrase in an address to the 1873 annual meeting of the British Association for the Advancement of Science:

"No physical hypothesis founded on any indisputable fact has yet explained the origin of the primordial protoplasm, and, above all, of its marvellous properties, which render evolution possible—in heredity and in adaptability, for these properties are the cause and not the effect of evolution. For the cause of this cause we have sought in vain among the physical forces which surround us, until we are at last compelled to rest upon an independent volition, a far-seeing intelligent design."

The phrase can be found again in *Humanism*, a 1903 book by one of the founders of classical pragmatism, F.C.S. Schiller: "It will not be possible to rule out the supposition that the process of evolution may be guided by an intelligent design". A derivative of the phrase appears in the Macmillan *Encyclopedia of Philosophy* (1967) in the article titled, "Teleological argument for the existence of God": "Stated most succinctly, the argument runs: The world exhibits teleological order (design, adaptation). Therefore, it was produced by an intelligent designer". Robert Nozick (1974) wrote: "Consider now complicated patterns which one would have thought would arise only through intelligent design". The phrases "intelligent design" and "intelligently designed" were used in a 1979 philosophy book *Chance or Design?* by James Horigan and the phrase "intelligent design" was used in a 1982 speech by Sir Fred Hoyle in his promotion of panspermia.



Use of the terms "creationism" versus "intelligent design" in sequential drafts of the book *Of Pandas and People*

The modern use of the words "intelligent design", as a term intended to describe a field of inquiry, began after the Supreme Court of the United States, in the case of *Edwards v. Aguillard* (1987), ruled that creationism is unconstitutional in public school science curricula. A Discovery Institute report says that Charles Thaxton, editor of *Of Pandas and People*, had picked the phrase up from a NASA scientist, and thought "That's just what I need, it's a good engineering term". In drafts of the book over one hundred uses of the root word "creation", such as "creationism" and "creation science", were changed, almost without exception, to "intelligent design", while "creationists" was changed to "design proponents" or, in one instance, "cdesign proponentsists". [*sic*] In June 1988 Thaxton held a conference titled "Sources of Information Content in DNA" in Tacoma, Washington, and in December decided to use the label "intelligent design" for his new creationist movement. Stephen C. Meyer was at the conference, and later recalled that "the term came up".

Of Pandas and People

Of Pandas and People was published in 1989, and was the first book to make frequent use of the phrases "intelligent design," "design proponents," and "design theory", thus

representing the beginning of the modern "intelligent design" movement. "Intelligent design" was the most prominent of around fifteen new terms it introduced as a new lexicon of creationist terminology to oppose evolution without using religious language. It was the first place where the phrase "intelligent design" appeared in its present use, as stated both by its publisher Jon Buell, and by William A. Dembski in his expert witness report.

The National Center for Science Education has criticized the book for presenting all of the basic arguments of intelligent design proponents and being actively promoted for use in public schools before any research had been done to support these arguments. Although presented as a scientific textbook, Philosopher of science Michael Ruse considers the contents "worthless and dishonest". An ACLU lawyer described it as a political tool aimed at students who did not "know science or understand the controversy over evolution and creationism." One of the authors of the science framework used by California Schools, Kevin Padian, scathingly condemned it for its "sub-text," "Intolerance for honest science" and "incompetence".

Concepts

Irreducible complexity

The concept of irreducible complexity was popularised by Michael Behe, in his 1996 book, *Darwin's Black Box*.

The term "irreducible complexity" was introduced by biochemist Michael Behe in his 1996 book *Darwin's Black Box*, though he had already described the concept in his contributions to the 1993 revised edition of *Of Pandas and People*. Behe defines it as "a single system which is composed of several well-matched interacting parts that contribute to the basic function, wherein the removal of any one of the parts causes the system to effectively cease functioning".

Behe uses the analogy of a mousetrap to illustrate this concept. A mousetrap consists of several interacting pieces—the base, the catch, the spring and the hammer—all of which must be in place for the mousetrap to work. Removal of any one piece destroys the function of the mousetrap. Intelligent design advocates assert that natural selection could not create irreducibly complex systems, because the selectable function is present only

when all parts are assembled. Behe argued that irreducibly complex biological mechanisms include the bacterial flagellum of *E. coli*, the blood clotting cascade, cilia, and the adaptive immune system.

Critics point out that the irreducible complexity argument assumes that the necessary parts of a system have always been necessary and therefore could not have been added sequentially. They argue that something which is at first merely advantageous can later become necessary as other components change. Furthermore, they argue, evolution often proceeds by altering preexisting parts or by removing them from a system, rather than by adding them. This is sometimes called the "scaffolding objection" by an analogy with scaffolding, which can support an "irreducibly complex" building until it is complete and able to stand on its own. Behe has acknowledged using "sloppy prose", and that his "argument against Darwinism does not add up to a logical proof". Irreducible complexity has remained a popular argument among advocates of intelligent design; in the Dover trial, the court held that "Professor Behe's claim for irreducible complexity has been refuted in peer-reviewed research papers and has been rejected by the scientific community at large".

Specified complexity

In 1986 the creationist chemist Charles Thaxton used the term "specified complexity" from information theory when claiming that messages transmitted by DNA in the cell were specified by intelligence, and must have originated with an intelligent agent. The intelligent design concept of "specified complexity" was developed in the 1990s by mathematician, philosopher, and theologian William Dembski. Dembski states that when something exhibits specified complexity (i.e., is both complex and "specified", simultaneously), one can infer that it was produced by an intelligent cause (i.e., that it was designed) rather than being the result of natural processes. He provides the following examples: "A single letter of the alphabet is specified without being complex. A long sentence of random letters is complex without being specified. A Shakespearean sonnet is both complex and specified". He states that details of living things can be similarly characterized, especially the "patterns" of molecular sequences in functional biological molecules such as DNA.

William Dembski proposed the concept of specified complexity.

Dembski defines complex specified information (CSI) as anything with a less than 1 in 10^{150} chance of occurring by (natural) chance. Critics say that this renders the argument a tautology: complex specified information cannot occur naturally because Dembski has defined it thus, so the real question becomes whether or not CSI actually exists in nature.

The conceptual soundness of Dembski's specified complexity/CSI argument has been widely discredited by the scientific and mathematical communities. Specified complexity has yet to be shown to have wide applications in other fields as Dembski asserts. John Wilkins and Wesley Elsberry characterize Dembski's "explanatory filter" as *eliminative*, because it eliminates explanations sequentially: first regularity, then chance, finally defaulting to design. They argue that this procedure is flawed as a model for scientific inference because the asymmetric way it treats the different possible explanations renders it prone to making false conclusions.

Richard Dawkins, another critic of intelligent design, argues in *The God Delusion* that allowing for an intelligent designer to account for unlikely complexity only postpones the problem, as such a designer would need to be at least as complex. Other scientists have argued that evolution through selection is better able to explain the observed complexity, as is evident from the use of selective evolution to design certain electronic, aeronautic and automotive systems which are considered problems too complex for human "intelligent designers".

Fine-tuned Universe

Intelligent design proponents have also occasionally appealed to broader teleological arguments outside of biology, most notably an argument based on the fine-tuning of universal constants that make matter and life possible and which are argued not to be solely attributable to chance. These include the values of fundamental physical constants,

the relative strength of nuclear forces, electromagnetism, and gravity between fundamental particles, as well as the ratios of masses of such particles. Intelligent design proponent and Center for Science and Culture fellow Guillermo Gonzalez argues that if any of these values were even slightly different, the universe would be dramatically different, making it impossible for many chemical elements and features of the Universe, such as galaxies, to form. Thus, proponents argue, an intelligent designer of life was needed to ensure that the requisite features were present to achieve that particular outcome.

Scientists have generally responded that this argument cannot be tested and is therefore not science but metaphysics. Some scientists argue that even when taken as mere speculation, these arguments are poorly supported by existing evidence. Victor J. Stenger and other critics say both intelligent design and the weak form of the anthropic principle are essentially a tautology; in his view, these arguments amount to the claim that life is able to exist because the Universe is able to support life. The claim of the improbability of a life-supporting universe has also been criticized as an argument by lack of imagination for assuming no other forms of life are possible. Life as we know it might not exist if things were different, but a different sort of life might exist in its place. A number of critics also suggest that many of the stated variables appear to be interconnected and that calculations made by mathematicians and physicists suggest that the emergence of a universe similar to ours is quite probable.

Proponent Granville Sewell argues that the evolution of complex forms of life represents a decrease of entropy, and that it thus violates the second law of thermodynamics and so supports intelligent design. This, however, is a misapplication of thermodynamic principles. The second law applies to closed systems only. If Granville's argument were valid, living things could not be born and grow, as this also would be a decrease in entropy. Neither evolution nor the growth of living things violates the second law of thermodynamics because living things are not closed systems—they have external energy sources (e.g. food, oxygen, sunlight) whose production requires an offsetting net increase in entropy.

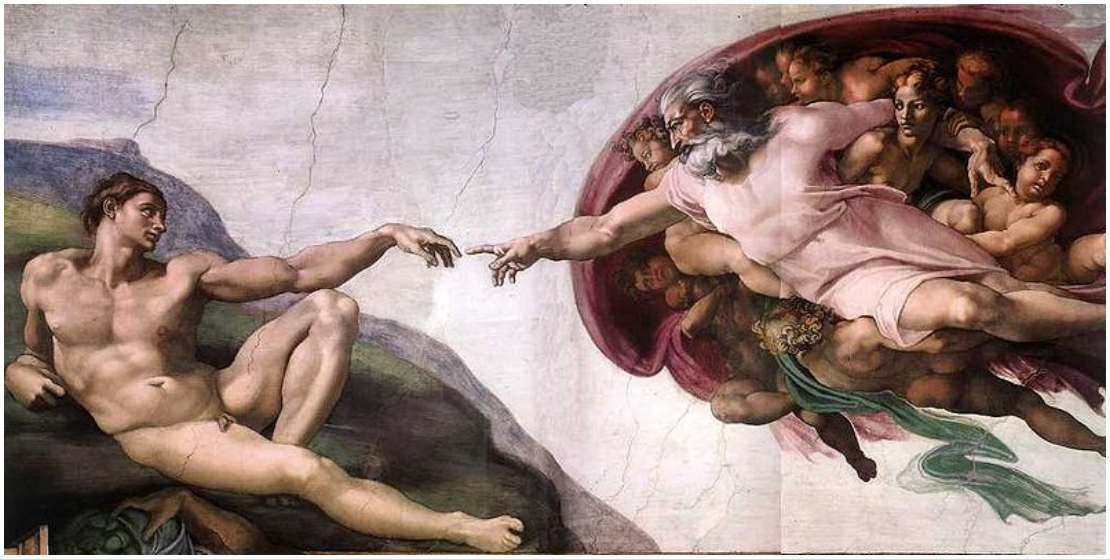
Intelligent designer

Intelligent design arguments are formulated in secular terms and intentionally avoid identifying the intelligent agent (or agents) they posit. Although they do not state that God is the designer, the designer is often implicitly hypothesized to have intervened in a way that only a god could intervene. Dembski, in *The Design Inference*, speculates that an alien culture could fulfill these requirements. The authoritative description of intelligent design, however, explicitly states that the *Universe* displays features of having been designed. Acknowledging the paradox, Dembski concludes that "no intelligent agent who is strictly physical could have presided over the origin of the universe or the origin of life". The leading proponents have made statements to their supporters that they believe the designer to be the Christian God, to the exclusion of all other religions.

Beyond the debate over whether intelligent design is scientific, a number of critics argue that existing evidence makes the design hypothesis appear unlikely, irrespective of its status in the world of science. For example, Jerry Coyne asks why a designer would "give us a pathway for making vitamin C, but then destroy it by disabling one of its enzymes" and why he or she would not "stock oceanic islands with reptiles, mammals, amphibians, and freshwater fish, despite the suitability of such islands for these species". Coyne also points to the fact that "the flora and fauna on those islands resemble that of the nearest mainland, even when the environments are very different" as evidence that species were not placed there by a designer. Previously, in *Darwin's Black Box*, Behe had argued that we are simply incapable of understanding the designer's motives, so such questions cannot be answered definitively. Odd designs could, for example, "have been placed there by the designer ... for artistic reasons, to show off, for some as-yet undetectable practical purpose, or for some unguessable reason". Coyne responds that in light of the evidence, "either life resulted not from intelligent design, but from evolution; or the intelligent designer is a cosmic prankster who designed everything to make it look as though it had evolved".

Asserting the need for a designer of complexity also raises the question "What designed the designer?" Intelligent design proponents say that the question is irrelevant to or outside the scope of intelligent design. Richard Wein counters that the unanswered questions an explanation creates "must be balanced against the improvements in our understanding which the explanation provides. Invoking an unexplained being to explain the origin of other beings (ourselves) is little more than question-begging. The new question raised by the explanation is as problematic as the question which the explanation purports to answer". Richard Dawkins sees the assertion that the designer does not need to be explained, not as a contribution to knowledge, but as a thought-terminating cliché. In the absence of observable, measurable evidence, the very question "What designed the designer?" leads to an infinite regression from which intelligent design proponents can only escape by resorting to religious creationism or logical contradiction.

Movement



The Discovery Institute's Center for the Renewal of Science and Culture used banners based on "The Creation of Adam" from the Sistine Chapel. Later it used a less religious image, then was renamed the Center for Science and Culture.

The intelligent design movement is a direct outgrowth of the creationism of the 1980s. The scientific and academic communities, along with a U.S. federal court, view intelligent design as either a form of creationism or as a direct descendant that is closely intertwined with traditional creationism; and several authors explicitly refer to it as "intelligent design creationism".

The movement is headquartered in the Center for Science and Culture (CSC), established in 1996 as the creationist wing of the Discovery Institute to promote a religious agenda calling for broad social, academic and political changes. The Discovery Institute's intelligent design campaigns have been staged primarily in the United States, although efforts have been made in other countries to promote intelligent design. Leaders of the movement say intelligent design exposes the limitations of scientific orthodoxy and of the secular philosophy of naturalism. Intelligent design proponents allege that science should not be limited to naturalism and should not demand the adoption of a naturalistic philosophy that dismisses out-of-hand any explanation which contains a supernatural cause. The overall goal of the movement is to "defeat [the] materialist world view" represented by the theory of evolution in favor of "a science consonant with Christian and theistic convictions".

Phillip E. Johnson stated that the goal of intelligent design is to cast creationism as a scientific concept. All leading intelligent design proponents are fellows or staff of the Discovery Institute and its Center for Science and Culture. Nearly all intelligent design concepts and the associated movement are the products of the Discovery Institute, which

guides the movement and follows its wedge strategy while conducting its Teach the Controversy campaign and their other related programs.

Leading intelligent design proponents have made conflicting statements regarding intelligent design. In statements directed at the general public, they say intelligent design is not religious; when addressing conservative Christian supporters, they state that intelligent design has its foundation in the Bible. Recognizing the need for support, the institute affirms its Christian, evangelistic orientation: "Alongside a focus on influential opinion-makers, we also seek to build up a popular base of support among our natural constituency, namely, Christians. We will do this primarily through apologetics seminars. We intend these to encourage and equip believers with new scientific evidences that support the faith, as well as to 'popularize' our ideas in the broader culture."

Barbara Forrest, an expert who has written extensively on the movement, describes this as being due to the Discovery Institute's obfuscating its agenda as a matter of policy. She has written that the movement's "activities betray an aggressive, systematic agenda for promoting not only intelligent design creationism, but the religious world-view that undergirds it".

Religion and leading proponents

Although arguments for intelligent design are formulated in secular terms and intentionally avoid positing the identity of the designer, the majority of principal intelligent design advocates are publicly religious Christians who have stated that in their view the designer proposed in intelligent design is the Christian conception of God. Stuart Burgess, Phillip E. Johnson, William Dembski, and Stephen C. Meyer are evangelical Protestants, and Michael Behe is a Roman Catholic, while Jonathan Wells is a member of the Unification Church. Phillip E. Johnson has stated that cultivating ambiguity by employing secular language in arguments that are carefully crafted to avoid overtones of theistic creationism is a necessary first step for ultimately reintroducing the Christian concept of God as the designer. Johnson explicitly calls for intelligent design proponents to obfuscate their religious motivations so as to avoid having intelligent design identified "as just another way of packaging the Christian evangelical message". Johnson emphasizes that "the first thing that has to be done is to get the Bible out of the discussion"; "after we have separated materialist prejudice from scientific fact [...] only then can 'biblical issues' be discussed".

The strategy of deliberately disguising the religious intent of intelligent design has been described by William Dembski in *The Design Inference*. In this work Dembski lists a god or an "alien life force" as two possible options for the identity of the designer; however, in his book *Intelligent Design: The Bridge Between Science and Theology,* Dembski states that "Christ is indispensable to any scientific theory, even if its practitioners don't have a clue about him. The pragmatics of a scientific theory can, to be sure, be pursued without recourse to Christ. But the conceptual soundness of the theory can in the end only be located in Christ." Dembski also stated, "ID is part of God's general revelation [...] Not only does intelligent design rid us of this ideology (materialism), which suffocates the

human spirit, but, in my personal experience, I've found that it opens the path for people to come to Christ". Both Johnson and Dembski cite the Bible's Gospel of John as the foundation of intelligent design.

Barbara Forrest contends such statements reveal that leading proponents see intelligent design as essentially religious in nature, not merely a scientific concept that has implications with which their personal religious beliefs happen to coincide. She writes that the leading proponents of intelligent design are closely allied with the ultra-conservative Christian Reconstructionism movement. She lists connections of (current and former) Discovery Institute Fellows Phillip Johnson, Charles Thaxton, Michael Behe, Richard Weikart, Jonathan Wells and Francis Beckwith to leading Christian Reconstructionist organizations, and the extent of the funding provided the Institute by Howard Ahmanson Jr., a leading figure in the Reconstructionist movement.

Reaction from other creationist groups

Not all creationist organizations have embraced the intelligent design movement. Hugh Ross of Reasons to Believe, a proponent of Old Earth creationism, believes that the efforts of intelligent design proponents to divorce the concept from Biblical Christianity make its hypothesis too vague. In 2002 he wrote: "Winning the argument for design without identifying the designer yields, at best, a sketchy origins model. Such a model makes little if any positive impact on the community of scientists and other scholars… The time is right for a direct approach, a single leap into the origins fray. Introducing a biblically based, scientifically verifiable creation model represents such a leap."

Likewise, two of the most prominent Young Earth creationism organizations in the world have attempted to distinguish their views from intelligent design. Henry M. Morris of the Institute for Creation Research (ICR) wrote, in 1999, that ID, "even if well-meaning and effectively articulated, will not work! It has often been tried in the past and has failed, and it will fail today. The reason it won't work is because it is not the Biblical method." According to Morris: "The evidence of intelligent design… must be either followed by or accompanied by a sound presentation of true Biblical creationism if it is to be meaningful and lasting." In 2002, Carl Wieland of Answers in Genesis (AiG) criticized design advocates who, though well-intentioned, "left the Bible out of it" and thereby unwittingly aided and abetted the modern rejection of the Bible. Wieland explained that "AiG's major 'strategy' is to boldly, but humbly, call the church back to its Biblical foundations… [so] we neither count ourselves a part of this movement nor campaign against it."

Polls

Several surveys were conducted prior to the December 2005 decision in *Kitzmiller v. Dover*, which sought to determine the level of support for intelligent design among certain groups. According to a 2005 Harris poll, 10% of adults in the United States viewed human beings as "so complex that they required a powerful force or intelligent being to help create them". Although Zogby polls commissioned by the Discovery Institute show more support, these polls suffer from considerable flaws, such as having a

very low response rate (248 out of 16,000), being conducted on behalf of an organization with an expressed interest in the outcome of the poll, and containing leading questions.

A May 2005 survey of nearly 1500 physicians in the United States conducted by the Louis Finkelstein Institute and HCD Research showed that 63% of the physicians agreed more with evolution than with intelligent design.

A series of Gallup polls in the United States from 1982 through 2008 on "Evolution, Creationism, Intelligent Design" found support for "human beings have developed over millions of years from less advanced formed of life, but God guided the process" of between 35% and 40%, support for "God created human beings in pretty much their present form at one time within the last 10,000 years or so" varied from 43% to 47%, and support for "human beings have developed over millions of years from less advanced formed of life, but God had no part in the process" varied from 9% to 14%. The polls also noted answers to a series of more detailed questions.

Film

The film *Expelled: No Intelligence Allowed* sparked further controversy in 2008. This documentary, hosted by Ben Stein, spends much time focusing on professors who have been asked to leave or have left numerous institutions because, the film insinuates, of their beliefs in Intelligent Design. One of the film's first screenings resulted in Paul "PZ" Myers, an interviewee in the film, being asked to leave the theater. There have also been allegations from some interviewees that interviews were recorded many times in order to get the exact phrasing required by the producer. The production company, Premise Media, also has helped finance some religious films such as *The Passion of the Christ*.

Creating and teaching the controversy

The intelligent design movement states that there is a debate among scientists about whether life evolved. The movement stresses the importance of recognizing the existence of this supposed debate, seeking to convince the public, politicians, and cultural leaders that schools should "Teach the Controversy". In fact, there is no such controversy in the scientific community; the scientific consensus is that life evolved. Intelligent design is widely viewed as a stalking horse for its proponents' campaign against what they say is the materialist foundation of science, which they argue leaves no room for the possibility of God.

Advocates of intelligent design seek to keep God and the Bible out of the discussion, and present intelligent design in the language of science as though it were a scientific hypothesis. However, among a significant proportion of the general public in the United States the major concern is whether conventional evolutionary biology is compatible with belief in God and in the Bible, and how this issue is taught in schools. The public controversy was given widespread media coverage in the United States, particularly during the *Kitzmiller v. Dover* trial in late 2005 and after President George W. Bush expressed support for the idea of teaching intelligent design alongside evolution in

August 2005. In response to Bush's statement and the pending federal trial, *Time* magazine ran an eight-page cover story on the Evolution Wars in which they examined the issue of teaching intelligent design in the classroom. The cover of the magazine featured a parody of The Creation of Adam from the Sistine Chapel. Rather than pointing at Adam, Michelangelo's God points at the image of a chimpanzee contemplating the caption which read "*The push to teach "intelligent design" raises a question: Does God have a place in science class?"*. In the *Kitzmiller v. Dover* case, the court ruled that intelligent design was a religious and creationist position, finding that God and intelligent design were both distinct from the material that should be covered in a science class.

Empirical science uses the scientific method to create *a posteriori* knowledge based on observation and repeated testing of hypotheses and theories. Intelligent design proponents seek to change this fundamental basis of science by eliminating "methodological naturalism" from science and replacing it with what the leader of the intelligent design movement, Phillip E. Johnson, calls "theistic realism". Some have called this approach "methodological supernaturalism", which means belief in a transcendent, nonnatural dimension of reality inhabited by a transcendent, nonnatural deity. Intelligent design proponents argue that naturalistic explanations fail to explain certain phenomena and that supernatural explanations provide a very simple and intuitive explanation for the origins of life and the universe. Proponents say evidence exists in the forms of irreducible complexity and specified complexity that cannot be explained by natural processes. They also hold that religious neutrality requires the teaching of both evolution and intelligent design in schools, saying that teaching only evolution unfairly discriminates against those holding creationist beliefs. Teaching both, they argue, allows for the possibility of religious belief, without causing the state to actually promote such beliefs. Many intelligent design followers believe that "Scientism" is itself a religion that promotes secularism and materialism in an attempt to erase theism from public life, and they view their work in the promotion of intelligent design as a way to return religion to a central role in education and other public spheres. Some allege that this larger debate is often the subtext for arguments made over intelligent design, though others note that intelligent design serves as an effective proxy for the religious beliefs of prominent intelligent design proponents in their efforts to advance their religious point of view within society.

Intelligent design has not presented a credible scientific case and is an attempt to teach religion in public schools, substituting public support for scientific research. If the argument to give "equal time for all theories" were actually practiced, there would be no logical limit to the number of mutually incompatible supernatural "theories" regarding the origins and diversity of life to be taught in the public school system, including intelligent design parodies such as the Flying Spaghetti Monster "theory"; intelligent design does not provide a mechanism for discriminating among them. Philosopher of biology Elliott Sober, for example, states that intelligent design is not falsifiable because "[d]efenders of ID always have a way out". Intelligent design proponent Michael Behe concedes "You can't prove intelligent design by experiment".

The inference that an intelligent designer created life on Earth, which advocate William Dembski has said could alternately be an "alien" life force, has been compared to the *a*

priori claim that aliens helped the ancient Egyptians build the pyramids. In both cases, the effect of this outside intelligence is not repeatable, observable or falsifiable, and it violates the principle of parsimony. From a strictly empirical standpoint, one may list what is known about Egyptian construction techniques, but one must admit ignorance about exactly how the Egyptians built the pyramids.

Supporters of intelligent design have also reached out to other faith groups with similar accounts of creation with the hope that the broader coalition will have greater influence in supporting science education that does not contradict their religious views. Many religious bodies have responded by expressing support for evolution. The Roman Catholic church has stated that religious faith is fully compatible with science, which is limited to dealing only with the natural world — a position described by the term *theistic evolution*. While some in the Roman Catholic Church reject Intelligent design for various philosophical and theological reasons, others, such as Christoph Schönborn, Archbishop of Vienna, have shown support for it. The arguments of intelligent design have been directly challenged by the over 10,000 clergy who signed the Clergy Letter Project. Prominent scientists who strongly express religious faith, such as the astronomer George Coyne and the biologist Ken Miller, have been at the forefront of opposition to intelligent design. While creationist organizations have welcomed intelligent design's support against naturalism, they have also been critical of its refusal to identify the designer, and have pointed to previous failures of the same argument.

Rabbi Natan Slifkin directly criticized the advocates of intelligent design as presenting a perspective of God that is dangerous to religion. Those who promote it as parallel to religion, he asserts, do not truly understand it. Slifkin criticizes intelligent design's advocacy of teaching their perspective in biology classes, wondering why no one claims that God's hand should be taught in other secular classes, such as history, physics or geology. Slifkin also asserts that the intelligent design movement is inordinately concerned with portraying God as "in control" when it comes to things that cannot be easily explained by science, but not in control in respect to things which *can* be explained by scientific theory. Kenneth Miller expressed a view similar to Slifkin's: "[T]he struggles of the Intelligent Design movement are best understood as clamorous and disappointing double failures - rejected by science because they do not fit the facts, and having failed religion because they think too little of God.

Defining science

The scientific method is a body of techniques for investigating phenomena and acquiring new knowledge of the natural world without assuming the existence or nonexistence of the supernatural, an approach sometimes called methodological naturalism. Intelligent design proponents believe that this can be equated to materialist metaphysical naturalism, and have often said that not only is their own position scientific, but it is even more scientific than evolution, and that they want a redefinition of science as a revived natural theology or natural philosophy to allow "non-naturalistic theories such as intelligent design". This presents a demarcation problem, which in the philosophy of science is

about how and where to draw the lines around science. For a theory to qualify as scientific, it is expected to be:

- **Consistent**
- **Parsimonious** (sparing in its proposed entities or explanations)
- **Useful** (describes and explains observed phenomena, and can be used predictively)
- **Empirically testable and falsifiable**
- **Based on multiple observations**, often in the form of controlled, repeated experiments
- **Correctable and dynamic** (modified in the light of observations that do not support it)
- **Progressive** (refines previous theories)
- **Provisional** or tentative (is open to experimental checking, and does not assert certainty)

For any theory, hypothesis or conjecture to be considered scientific, it must meet most, and ideally all, of these criteria. The fewer criteria are met, the less scientific it is; and if it meets only a few or none at all, then it cannot be treated as scientific in any meaningful sense of the word. Typical objections to defining intelligent design as science are that it lacks consistency, violates the principle of parsimony, is not scientifically useful, is not falsifiable, is not empirically testable, and is not correctable, dynamic, provisional or progressive.

Critics also say that the intelligent design doctrine does not meet the Daubert Standard, the criteria for scientific evidence mandated by the US Supreme Court. The Daubert Standard governs which evidence can be considered scientific in United States federal courts and most state courts. Its four criteria are:

- The theoretical underpinnings of the methods must yield testable predictions by means of which the theory could be falsified.
- The methods should preferably be published in a peer-reviewed journal.
- There should be a known rate of error that can be used in evaluating the results.
- The methods should be generally accepted within the relevant scientific community.

In *Kitzmiller v. Dover Area School District*, using these criteria and others mentioned above, Judge Jones ruled that "... we have addressed the seminal question of whether ID is science. We have concluded that it is not, and moreover that ID cannot uncouple itself from its creationist, and thus religious, antecedents".

Against this, the philosopher Thomas Nagel argues that intelligent design is very different from creation science, in that it does not depend on distortion of evidence, or on the assumption that it is immune to empirical evidence. It depends only on the idea that the hypothesis of a designer makes sense. Whatever the merits of the positions, he argues

that it is a scientific disagreement, not a disagreement between science and something else.

The U.S. National Academy of Sciences has stated that "creationism, intelligent design, and other claims of supernatural intervention in the origin of life or of species are not science because they are not testable by the methods of science." The U.S. National Science Teachers Association and the American Association for the Advancement of Science have termed it pseudoscience. Others in the scientific community have concurred, and some have called it junk science.

Peer review

The failure to follow the procedures of scientific discourse and the failure to submit work to the scientific community that withstands scrutiny have weighed against intelligent design being accepted as valid science. The intelligent design movement has not published a properly peer-reviewed article in a scientific journal.

Intelligent design, by appealing to a supernatural agent, directly conflicts with the principles of science, which limit its inquiries to empirical, observable and ultimately testable data and which require explanations to be based on empirical evidence. Dembski, Behe and other intelligent design proponents say bias by the scientific community is to blame for the failure of their research to be published. Intelligent design proponents believe that their writings are rejected for not conforming to purely naturalistic, non-supernatural mechanisms rather than because their research is not up to "journal standards", and that the merit of their articles is overlooked. Some scientists describe this claim as a conspiracy theory. Michael Shermer has rebutted the claim, noting "Anyone who thinks that scientists do not question Darwinism has never been to an evolutionary conference." He noted that scientists such as Joan Roughgarden and Lynn Margulis have challenged certain Darwinist theories and offered explanations of their own and despite this they "have not been persecuted, shunned, fired or even expelled. Why? Because they are doing science, not religion." The issue that supernatural explanations do not conform to the scientific method became a sticking point for intelligent design proponents in the 1990s, and is addressed in the wedge strategy as an aspect of science that must be challenged before intelligent design can be accepted by the broader scientific community.

Critics and advocates debate over whether intelligent design produces new research and has legitimately attempted to publish this research. For instance, the Templeton Foundation, a former funder of the Discovery Institute and a major supporter of projects seeking to reconcile science and religion, says that it asked intelligent design proponents to submit proposals for actual research, but none were ever submitted. Charles L. Harper Jr., foundation vice-president, said: "From the point of view of rigor and intellectual seriousness, the intelligent design people don't come out very well in our world of scientific review".

The only article published in a peer-reviewed scientific journal that made a case for intelligent design was quickly withdrawn by the publisher for having circumvented the

journal's peer-review standards. Written by the Discovery Institute's Center for Science & Culture Director Stephen C. Meyer, it appeared in the peer-reviewed journal *Proceedings of the Biological Society of Washington* in August 2004. The article was a literature review, which means that it did not present any new research, but rather culled quotations and claims from other papers to argue that the Cambrian explosion could not have happened by natural processes. The choice of venue for this article was also considered problematic, because it was so outside the normal subject matter. Dembski has written that "perhaps the best reason [to be skeptical of his ideas] is that intelligent design has yet to establish itself as a thriving scientific research program." In a 2001 interview, Dembski said that he stopped submitting to peer-reviewed journals because of their slow time-to-print and that he makes more money from publishing books.

In the Dover trial, the judge found that intelligent design features no scientific research or testing. There, intelligent design proponents cited just one paper, on simulation modeling of evolution by Behe and Snoke, which mentioned neither irreducible complexity nor intelligent design and which Behe admitted did not rule out known evolutionary mechanisms. Michael Lynch called the conclusions of the article "an artifact of unwarranted biological assumptions, inappropriate mathematical modeling, and faulty logic". In sworn testimony, however, Behe said: "There are no peer reviewed articles by anyone advocating for intelligent design supported by pertinent experiments or calculations which provide detailed rigorous accounts of how intelligent design of any biological system occurred". As summarized by the judge, Behe conceded that there are no peer-reviewed articles supporting his claims of intelligent design or irreducible complexity. In his ruling, the judge wrote: "A final indicator of how ID has failed to demonstrate scientific warrant is the complete absence of peer-reviewed publications supporting the theory".

The Discovery Institute insists that a number of intelligent design articles have been published in peer-reviewed journals, including in its list the two articles mentioned above. Critics, largely members of the scientific community, reject this claim, stating that no established scientific journal has yet published an intelligent design article. Rather, intelligent design proponents have set up their own journals with peer review that lacks impartiality and rigor, consisting entirely of intelligent design supporters.

Intelligence as an observable quality

The phrase *intelligent* design makes use of an assumption of the quality of an observable intelligence, a concept that has no scientific consensus definition. William Dembski, for example, has written that "Intelligence leaves behind a characteristic signature". The characteristics of intelligence are assumed by intelligent design proponents to be observable without specifying what the criteria for the measurement of intelligence should be. Dembski, instead, asserts that "in special sciences ranging from forensics to archaeology to SETI (the Search for Extraterrestrial Intelligence), appeal to a designing intelligence is indispensable". How this appeal is made and what this implies as to the definition of intelligence are topics left largely unaddressed. Seth Shostak, a researcher with the SETI Institute, disputed Dembski's comparison of SETI and intelligent design,

saying that intelligent design advocates base their inference of design on complexity—the argument being that some biological systems are too complex to have been made by natural processes—while SETI researchers are looking primarily for artificiality.

Critics say that the design detection methods proposed by intelligent design proponents are radically different from conventional design detection, undermining the key elements that make it possible as legitimate science. Intelligent design proponents, they say, are proposing both searching for a designer without knowing anything about that designer's abilities, parameters, or intentions (which scientists do know when searching for the results of human intelligence), as well as denying the very distinction between natural/artificial design that allows scientists to compare complex designed artifacts against the background of the sorts of complexity found in nature.

As a means of criticism, certain skeptics have pointed to a challenge of intelligent design derived from the study of artificial intelligence. The criticism is a counter to intelligent design claims about what makes a design intelligent, specifically that "no preprogrammed device can be truly intelligent, that intelligence is irreducible to natural processes". This claim is similar in type to an assumption of Cartesian dualism that posits a strict separation between "mind" and the material Universe. However, in studies of artificial intelligence, while there is an implicit assumption that supposed "intelligence" or creativity of a computer program is determined by the capabilities given to it by the computer programmer, artificial intelligence need not be bound to an inflexible system of rules. Rather, if a computer program can access randomness as a function, this effectively allows for a flexible, creative, and adaptive intelligence. Evolutionary algorithms, a subfield of machine learning (itself a subfield of artificial intelligence), have been used to mathematically demonstrate that randomness and selection can be used to "evolve" complex, highly adapted structures that are not explicitly designed by a programmer. Evolutionary algorithms use the Darwinian metaphor of random mutation, selection and the survival of the fittest to solve diverse mathematical and scientific problems that are usually not solvable using conventional methods. Intelligence derived from randomness is essentially indistinguishable from the "innate" intelligence associated with biological organisms, and poses a challenge to the intelligent design conception that intelligence itself necessarily requires a designer. Cognitive science continues to investigate the nature of intelligence along these lines of inquiry. The intelligent design community, for the most part, relies on the assumption that intelligence is readily apparent as a fundamental and basic property of complex systems.

Arguments from ignorance

Eugenie Scott, along with Glenn Branch and other critics, has argued that many points raised by intelligent design proponents are arguments from ignorance. In the argument from ignorance, a lack of evidence for one view is erroneously argued to constitute proof of the correctness of another view. Scott and Branch say that intelligent design is an argument from ignorance because it relies on a lack of knowledge for its conclusion: lacking a natural explanation for certain specific aspects of evolution, we assume intelligent cause. They contend most scientists would reply that the unexplained is not

unexplainable, and that "we don't know yet" is a more appropriate response than invoking a cause outside science. Particularly, Michael Behe's demands for ever more detailed explanations of the historical evolution of molecular systems seem to assume a false dichotomy, where either evolution or design is the proper explanation, and any perceived failure of evolution becomes a victory for design. Scott and Branch also contend that the supposedly novel contributions proposed by intelligent design proponents have not served as the basis for any productive scientific research.

God of the gaps

Intelligent design has also been characterized as a "god of the gaps" argument, which has the following form:

- There is a gap in scientific knowledge.
- The gap is filled with acts of God (or intelligent designer) and therefore proves the existence of God (or intelligent designer).

A god-of-the-gaps argument is the theological version of an argument from ignorance. A key feature of this type of argument is that it merely answers outstanding questions with explanations (often supernatural) that are unverifiable and ultimately themselves subject to unanswerable questions.

Historians of science observe that the astronomy of the earliest civilizations, although astonishing and incorporating mathematical constructions far in excess of any practical value, proved to be misdirected and of little importance to the development of science, because they failed to inquire more carefully into the mechanisms that drove the heavenly bodies across the sky. It was the Greek civilization which first practised science, although not yet a mathematically-oriented experimental science, but nevertheless an attempt to rationalize the world of natural experience without recourse to divine intervention. In this historically motivated definition of science any appeal to an intelligent creator is explicitly excluded for the paralysing effect it may have on the scientific progress.

Kitzmiller trial

Kitzmiller v. Dover Area School District was the first direct challenge brought in the United States federal courts against a public school district that required the presentation of intelligent design as an alternative to evolution. The plaintiffs successfully argued that intelligent design is a form of creationism, and that the school board policy thus violated the Establishment Clause of the First Amendment to the United States Constitution.

Eleven parents of students in Dover, Pennsylvania, sued the Dover Area School District over a statement that the school board required be read aloud in ninth-grade science classes when evolution was taught. The plaintiffs were represented by the American Civil Liberties Union (ACLU), Americans United for Separation of Church and State (AU) and Pepper Hamilton LLP. The National Center for Science Education (NCSE) acted as consultants for the plaintiffs. The defendants were represented by the Thomas More Law

Center. The suit was tried in a bench trial from September 26, 2005 to November 4, 2005 before Judge John E. Jones III. Ken Miller, Kevin Padian, Brian Alters, Robert Pennock, Barbara Forrest and John Haught served as expert witnesses for the prosecution. Michael Behe, Steve Fuller and Scott Minnich served as expert witnesses for the defense.

On December 20, 2005 Judge Jones issued his 139-page findings of fact and decision, ruling that the Dover mandate was unconstitutional, and barring intelligent design from being taught in Pennsylvania's Middle District public school science classrooms. The eight Dover school board members who voted for the intelligent design requirement were all defeated in a November 8, 2005 election by challengers who opposed the teaching of intelligent design in a science class, and the current school board president stated that the board does not intend to appeal the ruling.

In his finding of facts, Judge Jones made the following condemnation of the Teach the Controversy strategy:

"Moreover, ID's backers have sought to avoid the scientific scrutiny which we have now determined that it cannot withstand by advocating that the controversy, but not ID itself, should be taught in science class. This tactic is at best disingenuous, and at worst a canard."

Reaction

Judge Jones himself anticipated that his ruling would be criticized, saying in his decision that:

"Those who disagree with our holding will likely mark it as the product of an activist judge. If so, they will have erred as this is manifestly not an activist Court. Rather, this case came to us as the result of the activism of an ill-informed faction on a school board, aided by a national public interest law firm eager to find a constitutional test case on ID, who in combination drove the Board to adopt an imprudent and ultimately unconstitutional policy. The breathtaking inanity of the Board's decision is evident when considered against the factual backdrop which has now been fully revealed through this trial. The students, parents, and teachers of the Dover Area School District deserved better than to be dragged into this legal maelstrom, with its resulting utter waste of monetary and personal resources."

As Jones had predicted, John G. West, Associate Director of the Center for Science and Culture at Discovery Institute, said:

"The Dover decision is an attempt by an activist federal judge to stop the spread of a scientific idea and even to prevent criticism of Darwinian evolution through government-imposed censorship rather than open debate, and it won't work. He has conflated Discovery Institute's position with that of the Dover school board, and he totally misrepresents intelligent design and the motivations of the scientists who research it."

Newspapers have noted with interest that the judge is "a Republican and a churchgoer".

Subsequently, the decision has been examined in a search for flaws and conclusions, partly by intelligent design supporters aiming to avoid future defeats in court. In the Spring of 2007 the University of Montana Law review published three articles. In the first, David K. DeWolf, John G. West and Casey Luskin, all of the Discovery Institute, argued that intelligent design is a valid scientific theory, the Jones court should not have addressed the question of whether it was a scientific theory, and that the Kitzmiller decision will have no effect at all on the development and adoption of intelligent design as an alternative to standard evolutionary theory. In the second Peter Irons responded, arguing that the decision was extremely well reasoned and spells the death knell for the intelligent design efforts to introduce creationism in public schools, while in the third, DeWolf et al. answer the points made by Irons. However, fear of a similar lawsuit has resulted in other school boards abandoning intelligent design "teach the controversy" proposals.

In April 2010, the American Academy of Religion issued *Guidelines for Teaching About Religion in K-12 Public Schools in the United States* which included guidance that creation science or intelligent design should not be taught in science classes, as "Creation science and intelligent design represent worldviews that fall outside of the realm of science that is defined as (and limited to) a method of inquiry based on gathering observable and measurable evidence subject to specific principles of reasoning." However, they, as well as other "worldviews that focus on speculation regarding the origins of life represent another important and relevant form of human inquiry that is appropriately studied in literature or social sciences courses. Such study, however, must include a diversity of worldviews representing a variety of religious and philosophical perspectives and must avoid privileging one view as more legitimate than others."

Status outside the United States

Europe

In June 2007 the Council of Europe's "Committee on Culture, Science and Education" issued a report, *The dangers of creationism in education*, which states "Creationism in any of its forms, such as 'intelligent design', is not based on facts, does not use any scientific reasoning and its contents are pathetically inadequate for science classes." In describing the dangers posed to education by teaching creationism, it described intelligent design as "anti-science" and involving "blatant scientific fraud" and "intellectual deception" that "blurs the nature, objectives and limits of science" and links it and other forms of creationism to denialism. On October 4, 2007, the Council of Europe's Parliamentary Assembly approved a resolution stating that schools should "resist presentation of creationist ideas in any discipline other than religion", including "intelligent design" which it described as "the latest, more refined version of creationism", "presented in a more subtle way". The resolution emphasises that the aim of the report is not to question or to fight a belief, but to "warn against certain tendencies to pass off a belief as science".

In the United Kingdom, public education includes Religious Education as a compulsory subject, and many "faith schools" that teach the ethos of particular denominations. When it was revealed that a group called *Truth in Science* had distributed DVDs produced by the Discovery Institute affiliate Illustra Media featuring Discovery Institute fellows making the case for design in nature, and claimed they were being used by 59 schools, the Department for Education and Skills (DfES) stated that "Neither creationism nor intelligent design are taught as a subject in schools, and are not specified in the science curriculum" (part of the National Curriculum which does not apply to independent schools or to Education in Scotland). The DfES subsequently stated that "Intelligent design is not a recognised scientific theory; therefore, it is not included in the science curriculum", but left the way open for it to be explored in religious education in relation to different beliefs, as part of a syllabus set by a local Standing Advisory Council on Religious Education. In 2006 the Qualifications and Curriculum Authority produced a Religious Education model unit in which pupils can learn about religious and nonreligious views about creationism, intelligent design and evolution by natural selection.

On June 25, 2007, the UK Government responded to an e-Petition by saying that creationism and intelligent design should not be taught as science, though teachers would be expected to answer pupils' questions within the standard framework of established scientific theories. Detailed government "Creationism teaching guidance" for schools in England was published on September 18, 2007. It states that "Intelligent design lies wholly outside of science", has no underpinning scientific principles, or explanations, and is not accepted by the science community as a whole. Though it should not be taught as science, "questions about creationism and intelligent design which arise in science lessons, for example, as a result of media coverage, could provide the opportunity to explain or explore why they are not considered to be scientific theories and, in the right context, why evolution is considered to be a scientific theory". However, "Teachers of subjects such as RE, history or citizenship may deal with creationism and intelligent design in their lessons".

The British Centre for Science Education lobbying group has the goal of "countering creationism within the UK" and has been involved in government lobbying in the UK in this regard. However, in Northern Ireland the Democratic Unionist Party claims that the revised curriculum provides an opportunity for alternative theories to be taught, and has sought assurances that pupils will not lose marks if they give creationist or intelligent design answers to science questions. In Lisburn the DUP has arranged that the City Council will write to post primary schools asking what their plans are to develop teaching material in relation to "creation, intelligent design and other theories of origin".

Plans by Dutch Education Minister Maria van der Hoeven to "stimulate an academic debate" on the subject in 2005 caused a severe public backlash. After the 2007 elections she was succeeded by Ronald Plasterk, described as a "molecular geneticist, staunch atheist and opponent of intelligent design". As a reaction on this situation in the Netherlands, in Belgium the President of the Flemish Catholic Educational Board (VSKO) Mieke Van Hecke declared that: "Catholic scientists already accepted the theory

of evolution for a long time and that intelligent design and creationism doesn't belong in Flemish Catholic schools. It's not the tasks of the politics to introduce new ideas, that's task and goal of science."

Relation to Islam

Muzaffar Iqbal, a notable Muslim in Canada, signed the *Scientific Dissent* list of the Discovery Institute. Ideas similar to intelligent design have been considered respected intellectual options among Muslims, and in Turkey many intelligent design books have been translated. In Istanbul in 2007, public meetings promoting intelligent design were sponsored by the local government, and David Berlinski of the Discovery Institute was the keynote speaker at a meeting in May 2007.

Australia

The status of intelligent design in Australia is somewhat similar to that in the UK. When the former Australian Federal Education Minister, Brendan Nelson, raised the notion of intelligent design being taught in science classes, the public outcry caused the minister to quickly concede that the correct forum for intelligent design, if it were to be taught, is in religious or philosophy classes.

Chapter- 2

Irreducible Complexity

Irreducible complexity (IC) is a pseudoscientific argument by proponents of intelligent design that certain biological systems are too complex to have evolved from simpler, or "less complete" predecessors, through natural selection acting upon a series of advantageous naturally-occurring, chance mutations. The argument is central to intelligent design, and is rejected by the scientific community, which overwhelmingly regards intelligent design as pseudoscience. Irreducible complexity is one of two main arguments intended to support intelligent design, the other being specified complexity.

Biochemistry professor Michael Behe, the originator of the term *irreducible complexity*, defines an irreducibly complex system as one "composed of several well-matched, interacting parts that contribute to the basic function, wherein the removal of any one of the parts causes the system to effectively cease functioning". These examples are said to demonstrate that modern biological forms could not have evolved naturally. Evolutionary biologists have shown that such systems can in fact evolve, and Behe's examples are considered to constitute an argument from ignorance.

In the 2005 *Kitzmiller v. Dover Area School District* trial, Behe gave testimony on the subject of irreducible complexity. The court found that "Professor Behe's claim for irreducible complexity has been refuted in peer-reviewed research papers and has been rejected by the scientific community at large." Nonetheless, irreducible complexity continues to be cited as an important argument by creationists, particularly intelligent design proponents.

Definitions

The term "irreducible complexity" was coined by Behe, who defined it as applying to:

A single system which is composed of several interacting parts that contribute to the basic function, and where the removal of any one of the parts causes the system to effectively cease functioning.

Supporters of intelligent design use this term to refer to biological systems and organs that they believe could not have come about by any series of small changes. They argue that anything less than the complete form of such a system or organ would not work at

all, or would in fact be a *detriment* to the organism, and would therefore never survive the process of natural selection. Although they accept that some complex systems and organs *can* be explained by evolution, they claim that organs and biological features which are *irreducibly complex* cannot be explained by current models, and that an intelligent designer must have created life or guided its evolution. Accordingly, the debate on irreducible complexity concerns two questions: whether irreducible complexity can be found in nature, and what significance it would have if it did exist in nature.

A second definition given by Behe (his "evolutionary definition") is as follows:

An irreducibly complex evolutionary pathway is one that contains one or more unselected steps (that is, one or more necessary-but-unselected mutations). The degree of irreducible complexity is the number of unselected steps in the pathway.

Intelligent design advocate William Dembski gives this definition:

A system performing a given basic function is irreducibly complex if it includes a set of well-matched, mutually interacting, nonarbitrarily individuated parts such that each part in the set is indispensable to maintaining the system's basic, and therefore original, function. The set of these indispensable parts is known as the irreducible core of the system.

History

Forerunners

The argument from irreducible complexity is a descendant of the teleological argument for God (the argument from design or from complexity). This states that because certain things in nature are very complicated, they must have been designed. William Paley famously argued, in his 1802 watchmaker analogy, that complexity in nature implies a God for the same reason that the existence of a watch implies the existence of a watchmaker. This argument has a long history, and can be traced back at least as far as Cicero's *De natura deorum* ii.34.

Up to the 18th century

Galen (1st and 2nd centuries AD) wrote about the large number of parts of the body and their relationships, which observation was cited as evidence for creation. The idea that specifically the interdependence between parts would have implications for the origins of living things was raised by writers starting with Pierre Gassendi in the mid 17th century and John Wilkins, who wrote (citing Galen), "Now to imagine, that all these things, according to their several kinds, could be brought into this regular frame and order, to which such an infinite number of Intentions are required, without the contrivance of some wise Agent, must needs be irrational in the highest degree." In the late 17th century, Thomas Burnet referred to "a multitude of pieces aptly joyn’d" to argue against the eternity of life. In the early 18th century, Nicolas Malebranche wrote "An organized body

contains an infinity of parts that mutually depend upon one another in relation to particular ends, all of which must be actually formed in order to work as a whole," arguing in favor of preformation, rather than epigenesis, of the individual; and a similar argument about the origins of the individual was made by other 18th century students of natural history. In his 1790 book, *The Critique of Judgment*, Kant is said to argue that "we cannot conceive how a whole that comes into being only gradually from its parts can nevertheless be the cause of the properties of those parts"

19th century

As we transition to the 19th century, we find references which relate to evolution.

Chapter XV of Paley's *Natural Theology* discusses at length what he called "relations" of parts of living things as an indication of their design.

Georges Cuvier applied his principle of the *correlation of parts* to describe an animal from fragmentary remains. For Cuvier, this was related to another principle of his, the *conditions of existence*, which excluded the possibility of transmutation of species.

While he did not originate the term, Charles Darwin identified the argument as a possible way to falsify a prediction of the theory of evolution at the outset. In The Origin of Species, he wrote, "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. But I can find out no such case." Darwin's theory of evolution challenges the teleological argument by postulating an alternative explanation to that of an intelligent designer—namely, evolution by natural selection. By showing how simple unintelligent forces can ratchet up designs of extraordinary complexity without invoking outside design, Darwin showed that an intelligent designer was not the necessary conclusion to draw from complexity in nature. The argument from irreducible complexity attempts to demonstrate that certain biological features cannot be purely the product of Darwinian evolution.

In the late 19th century, in a dispute between supporters of the adequacy of natural selection and those who held for inheritance of acquired characters, one of the arguments made repeatedly by Herbert Spencer, and followed by others, depended on what Spencer referred to as *co-adaptation* of *co-operative* parts, as in: "We come now to Professor Weismann's endeavour to disprove my second thesis — that it is impossible to explain by natural selection alone the co-adaptation of co-operative parts. It is thirty years since this was set forth in "The Principles of Biology." In §166, I instanced the enormous horns of the extinct Irish elk, and contended that in this and in kindred cases, where for the efficient use of some one enlarged part many other parts have to be simultaneously enlarged, it is out of the question to suppose that they can have all spontaneously varied in the required proportions." The history of this concept in the dispute has been characterized: "An older and more religious tradition of idealist thinkers were committed to the explanation of complex adaptive contrivances by intelligent design. ... Another line of thinkers, unified by the recurrent publications of Herbert Spencer, also saw

coadaptation as a composed, irreducible whole, but sought to explain it by the inheritance of acquired characteristics."

20th century

Hermann Muller, in the early 20th century, discussed a concept similar to irreducible complexity. However, far from seeing this as a problem for evolution, he described the "interlocking" of biological features as a consequence to be expected of evolution, which would lead to irreversibility of some evolutionary changes. He wrote, "Being thus finally woven, as it were, into the most intimate fabric of the organism, the once novel character can no longer be withdrawn with impunity, and may have become vitally necessary."

In 1974, Young Earth Creationist Henry M. Morris introduced a similar concept in his book *Scientific Creationism* in which he wrote; "This issue can actually be attacked quantitatively, using simple principles of mathematical probability. The problem is simply whether a complex system, in which many components function unitedly together, and in which each component is uniquely necessary to the efficient functioning of the whole, could ever arise by random processes."

A book-length study of a concept similar to irreducible complexity, explained by gradual, step-wise, non-teleological evolution, was published in 1975 by Thomas H. Frazzetta. "A complex adaptation is one constructed of *several* components that must blend together operationally to make the adaptation "work". It is analogous to a machine whose performance depends upon careful cooperation among its parts. In the case of the machine, no single part can greatly be altered without changing the performance of the entire machine." The machine that he chose as an analog is the Peaucellier machine, and one biological system given extended description was the jaw apparatus of a python. The conclusion of this investigation, rather than that evolution of a complex adaptation was impossible, "awed by the adaptations of living things, to be stunned by their complexity and suitability", was "to accept the inescapable but not humiliating fact that much of mankind can be seen in a tree or a lizard."

In 1981, Ariel Roth, in defense of the creation science position in the trial *McLean v. Arkansas*, said of "complex integrated structures" that "This system would not be functional until all the parts were there ... How did these parts survive during evolution ...?"

In 1985 Cairns-Smith wrote of "interlocking", "How can a complex collaboration between components evolve in small steps?" and used the analogy of the scaffolding called centering used to build an arch then removed afterwards: "Surely there was 'scaffolding'. Before the multitudinous components of present biochemistry could come to lean together *they had to lean on something else.*" However, neither Muller or Cairns-Smith claimed that their ideas were evidence of something supernatural.

An essay in support of creationism published in 1994 referred to bacterial flagella as showing "multiple, integrated components", where "nothing about them works unless

every one of their complexly fashioned and integrated components are in place" and asked the reader to "imagine the effects of natural selection on those organisms that fortuitously evolved the flagella ... without the concommitant [*sic*] control mechanisms".

An early concept of irreducibly complex systems comes from Ludwig von Bertalanffy, a 20th-century Austrian biologist. He believed that complex systems must be examined as complete, irreducible systems in order to fully understand how they work. He extended his work on biological complexity into a general theory of systems in a book titled *General Systems Theory*. After James Watson and Francis Crick published the structure of DNA in the early 1950s, General Systems Theory lost many of its adherents in the physical and biological sciences. However, Systems theory remained popular in the social sciences long after its demise in the physical and biological sciences.

Origins

Michael Behe developed his ideas on the concept around 1992, in the early days of the 'wedge movement', and first presented his ideas about "irreducible complexity" in June 1993 when the "Johnson-Behe cadre of scholars" met at Pajaro Dunes in California. He set out his ideas in the second edition of *Of Pandas and People* published in 1993, extensively revising Chapter 6 *Biochemical Similarities* with new sections on the complex mechanism of blood clotting and on the origin of proteins.

He first used the term "irreducible complexity" in his 1996 book *Darwin's Black Box*, to refer to certain complex biochemical cellular systems. He posits that evolutionary mechanisms cannot explain the development of such "irreducibly complex" systems. Notably, Behe credits philosopher William Paley for the original concept, not von Bertalanffy, and suggests that his application of the concept to biological systems is entirely original. Intelligent design advocates argue that irreducibly complex systems must have been deliberately engineered by some form of intelligence.

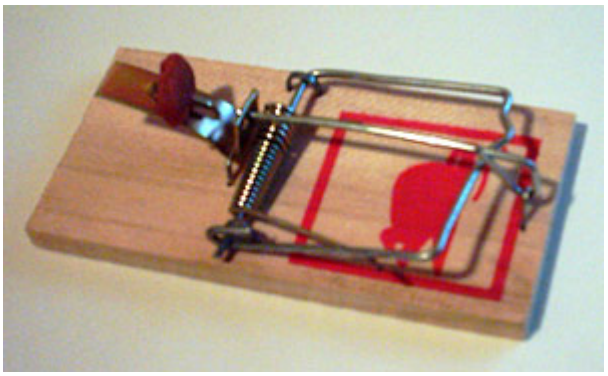
In 2001, Michael Behe wrote: "[T]here is an asymmetry between my current definition of irreducible complexity and the task facing natural selection. I hope to repair this defect in future work." Behe specifically explained that the "current definition puts the focus on removing a part from an already functioning system", but the "difficult task facing Darwinian evolution, however, would not be to remove parts from sophisticated pre-existing systems; it would be to bring together components to make a new system in the first place". In the 2005 *Kitzmiller v. Dover Area School District* trial, Behe testified under oath that he "did not judge [the asymmetry] serious enough to [have revised the book] yet."

Behe additionally testified that the presence of irreducible complexity in organisms would not rule out the involvement of evolutionary mechanisms in the development of organic life. He further testified that he knew of no earlier "peer reviewed articles in scientific journals discussing the intelligent design of the blood clotting cascade," but that there were "probably a large number of peer reviewed articles in science journals that demonstrate that the blood clotting system is indeed a purposeful arrangement of parts of

great complexity and sophistication." (The judge ruled that "intelligent design is not science and is essentially religious in nature".)

According to the theory of evolution, genetic variations occur without specific design or intent. The environment "selects" the variants that have the highest fitness, which are then passed on to the next generation of organisms. Change occurs by the gradual operation of natural forces over time, perhaps slowly, perhaps more quickly. This process is able to adapt complex structures from simpler beginnings, or convert complex structures from one function to another. Most intelligent design advocates accept that evolution occurs through mutation and natural selection at the "micro level", such as changing the relative frequency of various beak lengths in finches, but assert that it cannot account for irreducible complexity, because none of the parts of an irreducible system would be functional or advantageous until the entire system is in place.

The mousetrap analogy



Michael Behe believes that many aspects of life show evidence of design, using the mousetrap in an analogy disputed by others.

Behe uses the mousetrap as an illustrative example of this concept. A mousetrap consists of five interacting pieces—the base, the catch, the spring, the hammer and the hold-down bar. All of these must be in place for the mousetrap to work, as the removal of any one piece destroys the function of the mousetrap. Likewise, he asserts that biological systems require multiple parts working together in order to function. Intelligent design advocates claim that natural selection could not create from scratch those systems for which science is currently unable to find a viable evolutionary pathway of successive, slight modifications, because the selectable function is only present when all parts are assembled.

In his 2008 book *Only A Theory*, biologist Kenneth R. Miller challenges Behe's claim that the mousetrap is irreducibly complex. Miller observes that various subsets of the five components can be devised to form cooperative units, ones that have different functions from the mousetrap and so, in biological terms, could form functional spandrels before being adapted to the new function of catching mice. In an example taken from his high school experience, Miller recalls that one of his classmates

...struck upon the brilliant idea of using an old, broken mousetrap as a spitball catapult, and it worked brilliantly....It had worked perfectly as something other than a mousetrap....my rowdy friend had pulled a couple of parts --probably the hold-down bar and catch-- off the trap to make it easier to conceal and more effective as a catapult...[leaving] the base, the spring, and the hammer. Not much of a mousetrap, but a helluva spitball launcher....I realized why [Behe's] mousetrap analogy had bothered me. It was wrong. The mousetrap is not irreducibly complex after all.

Other systems identified by Miller that include mousetrap components include the following:

- use the spitball launcher as a tie clip (same three-part system with different function)
- remove the spring from the spitball launcher/tie clip to create a two-part key chain (base + hammer)
- glue the spitball launcher/tie clip to a sheet of wood to create a clipboard (launcher + glue + wood)
- remove the hold-down bar for use as a toothpick (single element system)

Behe has responded, "What Miller actually means is that if you take away some components and then go on to, say, twist a couple of metal pieces in just the right way and add a few staples in the correct positions, you can construct a new kind of working trap, which may superficially resemble the starting trap. That, however, is intelligent design. Neither Miller nor anyone else has shown that the mousetrap I pictured in my book can be constructed by a series of small changes, one at a time, as Darwinian evolution would have to do."

Consequences of irreducible complexity

Behe's original examples of irreducibly complex mechanisms included the bacterial flagellum of *E. coli*, the blood clotting cascade, cilia, and the adaptive immune system.

Behe argues that organs and biological features which are irreducibly complex cannot be wholly explained by current models of evolution. In explicating his definition of "irreducible complexity" he notes that:

An irreducibly complex system cannot be produced directly (that is, by continuously improving the initial function, which continues to work by the same mechanism) by slight, successive modifications of a precursor system, because any precursor to an irreducibly complex system that is missing a part is by definition nonfunctional.

Irreducible complexity is not an argument that evolution does not occur, but rather an argument that it is "incomplete". In the last chapter of *Darwin's Black Box*, Behe goes on to explain his view that irreducible complexity is evidence for intelligent design. Mainstream critics, however, argue that irreducible complexity, as defined by Behe, can be generated by known evolutionary mechanisms. Behe's claim that no scientific

literature adequately modeled the origins of biochemical systems through evolutionary mechanisms has been challenged by TalkOrigins. The judge in the *Dover* trial wrote "By defining irreducible complexity in the way that he has, Professor Behe attempts to exclude the phenomenon of exaptation by definitional fiat, ignoring as he does so abundant evidence which refutes his argument. Notably, the NAS has rejected Professor Behe's claim for irreducible complexity..."

Stated examples

Behe and others have suggested a number of biological features that they believe may be irreducibly complex.

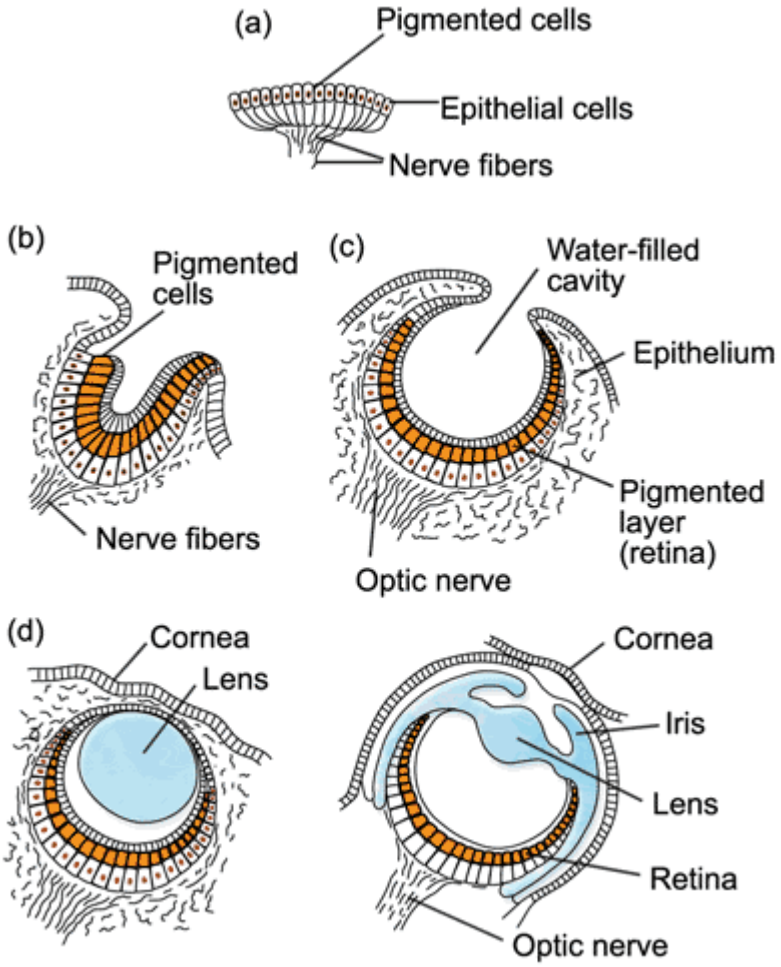
Blood clotting cascade

The blood clotting or coagulation cascade in vertebrates is a complex biological pathway which is given as an example of apparent irreducible complexity.

The irreducible complexity argument assumes that the necessary parts of a system have always been necessary, and therefore could not have been added sequentially. However, in evolution, something which is at first merely advantageous can later become necessary. Natural selection can lead to complex biochemical systems being built up from simpler systems, or to existing functional systems being recombined as a new system with a different function. For example, one of the clotting factors that Behe listed as a part of the clotting cascade was later found to be absent in whales, demonstrating that it is not essential for a clotting system. Many purportedly irreducible structures can be found in other organisms as much simpler systems that utilize fewer parts. These systems, in turn, may have had even simpler precursors that are now extinct. Behe has responded to critics of his clotting cascade arguments by suggesting that homology is evidence for evolution, but not for natural selection.

The "improbability argument" also misrepresents natural selection. It is correct to say that a set of simultaneous mutations that form a complex protein structure is so unlikely as to be unfeasible, but that is not what Darwin advocated. His explanation is based on small accumulated changes that take place without a final goal. Each step must be advantageous in its own right, although biologists may not yet understand the reason behind all of them—for example, jawless fish accomplish blood clotting with just six proteins instead of the full 10.

Eye

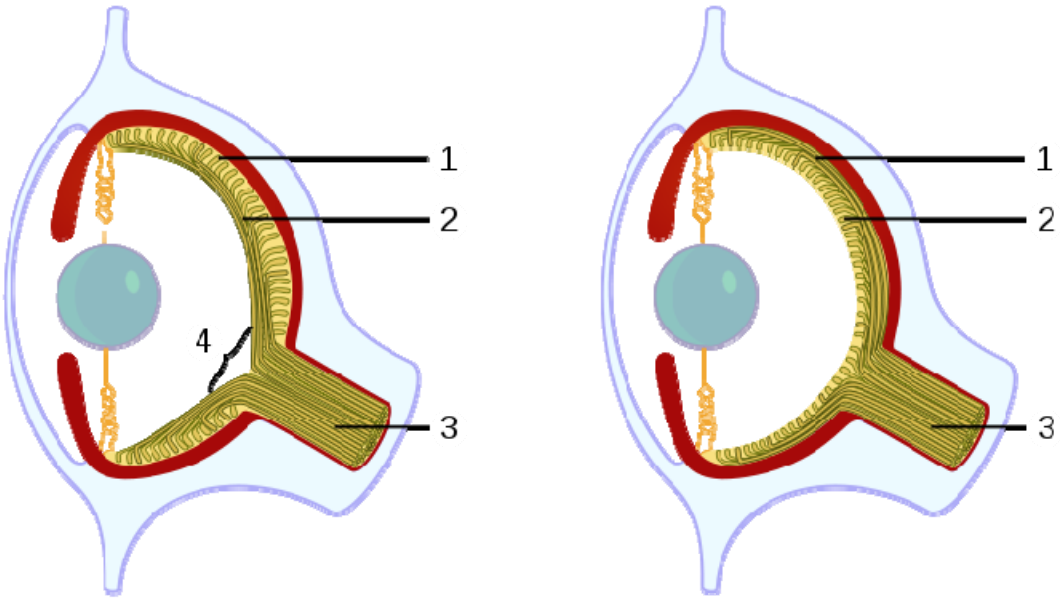


Often used as an example of irreducible complexity.
(a) A pigment spot
(b) A simple pigment cup
(c) The simple optic cup found in abalone
(d) The complex lensed eye of the marine snail and the octopus

The eye is a famous example of a supposedly irreducibly complex structure, due to its many elaborate and interlocking parts, seemingly all dependent upon one another. It is frequently cited by intelligent design and creationism advocates as an example of irreducible complexity. Behe used the "development of the eye problem" as evidence for intelligent design in *Darwin's Black Box*. Although Behe acknowledged that the evolution of the larger anatomical features of the eye have been well-explained, he claimed that the complexity of the minute biochemical reactions required at a molecular level for light sensitivity still defies explanation. Creationist Jonathan Sarfati has described the eye as evolutionary biologists' "greatest challenge as an example of superb

'irreducible complexity' in God's creation", specifically pointing to the supposed "vast complexity" required for transparency.

In an often misquoted passage from *On the Origin of Species*, Charles Darwin appears to acknowledge the eye's development as a difficulty for his theory. However, the quote in context shows that Darwin actually had a very good understanding of the evolution of the eye. He notes that "to suppose that the eye ... could have been formed by natural selection, seems, I freely confess, absurd in the highest possible degree". Yet this observation was merely a rhetorical device for Darwin. He goes on to explain that if gradual evolution of the eye could be shown to be possible, "the difficulty of believing that a perfect and complex eye could be formed by natural selection ... can hardly be considered real". He then proceeded to roughly map out a likely course for evolution using examples of gradually more complex eyes of various species.



The eyes of vertebrates (left) and invertebrates such as the octopus (right) developed independently: vertebrates evolved an inverted retina with a blind spot over their optic disc, whereas octopuses avoided this with a non-inverted retina.

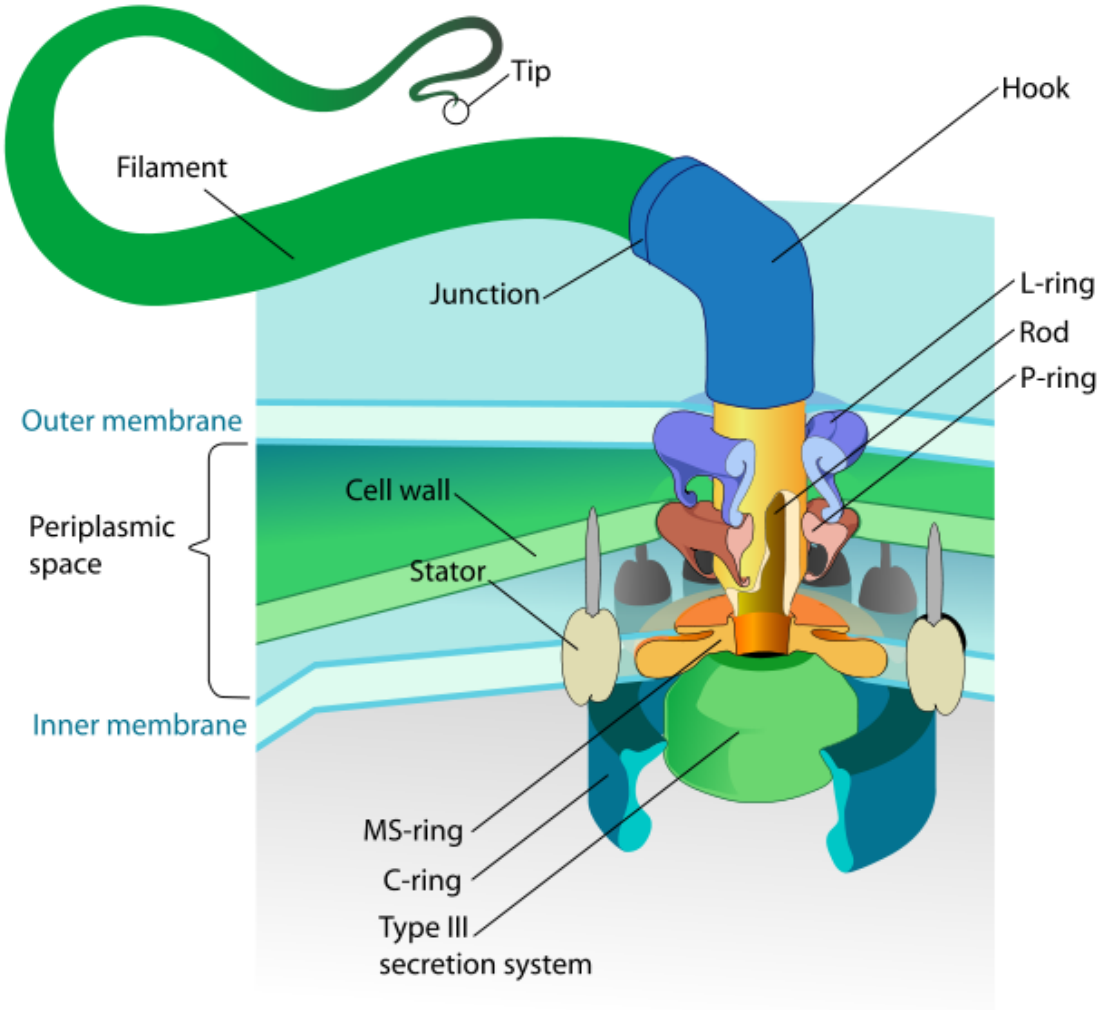
Since Darwin's day, the eye's ancestry has become much better understood. Although learning about the construction of ancient eyes through fossil evidence is problematic due to the soft tissues leaving no imprint or remains, genetic and comparative anatomical evidence has increasingly supported the idea of a common ancestry for all eyes.

Current evidence does suggest possible evolutionary lineages for the origins of the anatomical features of the eye. One likely chain of development is that the eyes originated as simple patches of photoreceptor cells that could detect the presence or absence of light, but not its direction. When, via random mutation across the population, the photosensitive cells happened to have developed on a small depression, it endowed

the organism with a better sense of the light's source. This small change gave the organism an advantage over those without the mutation. This genetic trait would then be "selected for" as those with the trait would have an increased chance of survival, and therefore progeny, over those without the trait. Individuals with deeper depressions would be able to discern changes in light over a wider field than those individuals with shallower depressions. As ever deeper depressions were advantageous to the organism, gradually, this depression would become a pit into which light would strike certain cells depending on its angle. The organism slowly gained increasingly precise visual information. And again, this gradual process continued as individuals having a slightly shrunken aperture of the eye had an advantage over those without the mutation as an aperture increases how collimated the light is at any one specific group of photoreceptors. As this trait developed, the eye became effectively a pinhole camera which allowed the organism to dimly make out shapes—the nautilus is a modern example of an animal with such an eye. Finally, via this same selection process, a protective layer of transparent cells over the aperture was differentiated into a crude lens, and the interior of the eye was filled with humours to assist in focusing images. In this way, eyes are recognized by modern biologists as actually a relatively unambiguous and simple structure to evolve, and many of the major developments of the eye's evolution are believed to have taken place over only a few million years, during the Cambrian explosion.

Behe maintains that the complexity of light sensitivity at the molecular level and the minute biochemical reactions required for those first "simple patches of photoreceptor[s]" still defies explanation. Other intelligent design proponents have pointed to the difficulty of the entire visual system evolving rather than the eye alone.

Flagella



The bacterial flagellum is frequently invoked as an example of irreducible complexity.

The flagella of certain bacteria constitute a molecular motor requiring the interaction of about 40 complex protein parts. Behe asserts that the absence of any one of these proteins causes the flagella to fail to function, and that the flagellum "engine" is irreducibly complex as in his view if we try to reduce its complexity by positing an earlier and simpler stage of its evolutionary development, we get an organism which functions improperly.

Scientists regard this argument as having been disproved in the light of research dating back to 1996 as well as more recent findings. They point out that the basal body of the flagella has been found to be similar to the Type III secretion system (TTSS), a needle-like structure that pathogenic germs such as *Salmonella* and *Yersinia pestis* use to inject toxins into living eucaryote cells. The needle's base has ten elements in common with the flagellum, but it is missing forty of the proteins that make a flagellum work. Thus, this system negates the claim that taking away any of the flagellum's parts would render it

useless. On this basis, Kenneth Miller notes that, "The parts of this supposedly irreducibly complex system actually have functions of their own."

Response of the scientific community

Like intelligent design, the concept it seeks to support, irreducible complexity has failed to gain any notable acceptance within the scientific community. One science writer called it a "full-blown intellectual surrender strategy."

Reducibility of "irreducible" systems

Potentially viable evolutionary pathways have been proposed for allegedly irreducibly complex systems such as blood clotting, the immune system and the flagellum, which were the three examples Behe used. Even his example of a mousetrap was shown to be reducible by John H. McDonald. If irreducible complexity is an insurmountable obstacle to evolution, it should not be possible to conceive of such pathways.

Niall Shanks and Karl H. Joplin, both of East Tennessee State University, have shown that systems satisfying Behe's characterization of irreducible biochemical complexity can arise naturally and spontaneously as the result of self-organizing chemical processes. They also assert that what evolved biochemical and molecular systems actually exhibit is "redundant complexity"—a kind of complexity that is the product of an evolved biochemical process. They claim that Behe overestimated the significance of irreducible complexity because of his simple, linear view of biochemical reactions, resulting in his taking snapshots of selective features of biological systems, structures and processes, while ignoring the redundant complexity of the context in which those features are naturally embedded. They also criticized his over-reliance of overly simplistic metaphors, such as his mousetrap. In addition, research published in the peer-reviewed journal Nature has shown that computer simulations of evolution demonstrate that it is possible for irreducible complexity to evolve naturally.

It is illustrative to compare a mousetrap with a cat, in this context. Both normally function so as to control the mouse population. The cat has many parts that can be removed leaving it still functional; for example, its tail can be bobbed, or it can lose an ear in a fight. Comparing the cat and the mousetrap, then, one sees that the mousetrap (which is not alive) offers better evidence, in terms of irreducible complexity, for intelligent design than the cat. Even looking at the mousetrap analogy, several critics have described ways in which the parts of the mousetrap could have independent uses or could develop in stages, demonstrating that it is not irreducibly complex.

Moreover, even cases where removing a certain component in an organic system will cause the system to fail do not demonstrate that the system couldn't have been formed in a step-by-step, evolutionary process. By analogy, stone arches are irreducibly complex—if you remove any stone the arch will collapse—yet we build them easily enough, one stone at a time, by building over centering that is removed afterward. Similarly, naturally occurring arches of stone are formed by weathering away bits of stone from a large

concretion that has formed previously. Evolution can act to simplify as well as to complicate. This raises the possibility that seemingly irreducibly complex biological features may have been achieved with a period of increasing complexity, followed by a period of simplification.

In April 2006 a team led by Joe Thornton, assistant professor of biology at the University of Oregon's Center for Ecology and Evolutionary Biology, using techniques for resurrecting ancient genes, scientists for the first time reconstructed the evolution of an apparently irreducibly complex molecular system. The research was published in the April 7 issue of *Science*.

It may be that irreducible complexity does not actually exist in nature, and that the examples given by Behe and others are not in fact irreducibly complex, but can be explained in terms of simpler precursors. There has also been a theory that challenges irreducible complexity called facilitated variation. The theory has been presented in 2005 by Marc W. Kirschner, a professor and chair of Department of Systems Biology at Harvard Medical School, and John C. Gerhart, a professor in Molecular and Cell Biology, University of California, Berkeley. In their theory, they describe how certain mutation and changes can cause apparent irreducible complexity. Thus, seemingly irreducibly complex structures are merely "very complex", or they are simply misunderstood or misrepresented.

Gradual adaptation to new functions

The precursors of complex systems, when they are not useful in themselves, may be useful to perform other, unrelated functions. Evolutionary biologists argue that evolution often works in this kind of blind, haphazard manner in which the function of an early form is not necessarily the same as the function of the later form. The term used for this process is "exaptation". The mammalian middle ear (derived from a jawbone) and the panda's thumb (derived from a wrist bone spur) are considered classic examples. A 2006 article in *Nature* demonstrates intermediate states leading toward the development of the ear in a Devonian fish (about 360 million years ago). Furthermore, recent research shows that viruses play a heretofore unexpectedly great role in evolution by mixing and matching genes from various hosts.

Arguments for irreducibility often assume that things started out the same way they ended up—as we see them now. However, that may not necessarily be the case. In the *Dover* trial an expert witness for the plaintiffs, Ken Miller, demonstrated this possibility using Behe's mousetrap analogy. By removing several parts, Miller made the object unusable as a mousetrap, but he pointed out that it was now a perfectly functional, if unstylish, tie clip.

Falsifiability and experimental evidence

Some critics, such as Jerry Coyne (professor of evolutionary biology at the University of Chicago) and Eugenie Scott (a physical anthropologist and executive director of the

National Center for Science Education) have argued that the concept of irreducible complexity, and more generally, the theory of intelligent design is not falsifiable, and therefore, not scientific.

Behe argues that the theory that irreducibly complex systems could not have been evolved can be falsified by an experiment where such systems are evolved. For example, he posits taking bacteria with no flagellum and imposing a selective pressure for mobility. If, after a few thousand generations, the bacteria evolved the bacterial flagellum, then Behe believes that this would refute his theory.

Other critics take a different approach, pointing to experimental evidence that they believe falsifies the argument for Intelligent Design from irreducible complexity. For example, Kenneth Miller cites the lab work of Barry G. Hall on E. coli, which he asserts is evidence that "Behe is wrong."

Other evidence that irreducible complexity is not a problem for evolution comes from the field of computer science, where computer analogues of the processes of evolution are routinely used to automatically design complex solutions to problems. The results of such Genetic Algorithms are frequently irreducibly complex since the process, like evolution, both removes non-essential components over time as well as adding new components. The removal of unused components with no essential function, like the natural process where rock underneath a natural arch is removed, can produce irreducibly complex structures without requiring the intervention of a designer. Researchers applying these algorithms are automatically producing human competitive designs—but no human designer is required.

Argument from ignorance

Intelligent design proponents attribute to an intelligent designer those biological structures they believe are irreducibly complex and whereof they say a natural explanation is insufficient to account for them. However, critics view irreducible complexity as a special case of the "complexity indicates design" claim, and thus see it as an argument from ignorance and God of the gaps argument.

Eugenie Scott, along with Glenn Branch and other critics, has argued that many points raised by intelligent design proponents are arguments from ignorance. Behe has been accused of using an "argument by lack of imagination", and Behe himself acknowledges that a failure of current science to explain how an "irreducibly complex" organism did or could evolve does not automatically prove the impossibility of such an evolution.

Irreducible complexity is at its core an argument against evolution. If truly irreducible systems are found, the argument goes, then intelligent design must be the correct explanation for their existence. However, this conclusion is based on the assumption that current evolutionary theory and intelligent design are the only two valid models to explain life, a false dilemma.

Irreducible complexity in the Dover trial

While testifying at the Kitzmiller v. Dover Area School District trial Behe conceded that there are no peer-reviewed papers supporting his claims that complex molecular systems, like the bacterial flagellum, the blood-clotting cascade, and the immune system, were intelligently designed nor are there any peer-reviewed articles supporting his argument that certain complex molecular structures are "irreducibly complex."

In the final ruling of *Kitzmiller v. Dover Area School District*, Judge Jones specifically singled out Behe and irreducible complexity:

- "Professor Behe admitted in "Reply to My Critics" that there was a defect in his view of irreducible complexity because, while it purports to be a challenge to natural selection, it does not actually address "the task facing natural selection." and that "Professor Behe wrote that he hoped to "repair this defect in future work..." (Page 73)
- "As expert testimony revealed, the qualification on what is meant by "irreducible complexity" renders it meaningless as a criticism of evolution. (3:40 (Miller)). In fact, the theory of evolution proffers exaptation as a well-recognized, well-documented explanation for how systems with multiple parts could have evolved through natural means." (Page 74)
- "By defining irreducible complexity in the way that he has, Professor Behe attempts to exclude the phenomenon of exaptation by definitional fiat, ignoring as he does so abundant evidence which refutes his argument. Notably, the NAS has rejected Professor Behe's claim for irreducible complexity..." (Page 75)
- "As irreducible complexity is only a negative argument against evolution, it is refutable and accordingly testable, unlike ID [Intelligent Design], by showing that there are intermediate structures with selectable functions that could have evolved into the allegedly irreducibly complex systems. (2:15-16 (Miller)). Importantly, however, the fact that the negative argument of irreducible complexity is testable does not make testable the argument for ID. (2:15 (Miller); 5:39 (Pennock)). Professor Behe has applied the concept of irreducible complexity to only a few select systems: (1) the bacterial flagellum; (2) the blood-clotting cascade; and (3) the immune system. Contrary to Professor Behe's assertions with respect to these few biochemical systems among the myriad existing in nature, however, Dr. Miller presented evidence, based upon peer-reviewed studies, that they are not in fact irreducibly complex." (Page 76)
- "...on cross-examination, Professor Behe was questioned concerning his 1996 claim that science would never find an evolutionary explanation for the immune system. He was presented with fifty-eight peer-reviewed publications, nine books, and several immunology textbook chapters about the evolution of the immune system; however, he simply insisted that this was still not sufficient evidence of evolution, and that it was not "good enough." (23:19 (Behe))." (Page 78)
- "We therefore find that Professor Behe's claim for irreducible complexity has been refuted in peer-reviewed research papers and has been rejected by the scientific community at large. (17:45-46 (Padian); 3:99 (Miller)). Additionally,

even if irreducible complexity had not been rejected, it still does not support ID as it is merely a test for evolution, not design. (2:15, 2:35-40 (Miller); 28:63-66 (Fuller)). We will now consider the purportedly "positive argument" for design encompassed in the phrase used numerous times by Professors Behe and Minnich throughout their expert testimony, which is the "purposeful arrangement of parts." Professor Behe summarized the argument as follows: We infer design when we see parts that appear to be arranged for a purpose. The strength of the inference is quantitative; the more parts that are arranged, the more intricately they interact, the stronger is our confidence in design. The appearance of design in aspects of biology is overwhelming. Since nothing other than an intelligent cause has been demonstrated to be able to yield such a strong appearance of design, Darwinian claims notwithstanding, the conclusion that the design seen in life is real design is rationally justified. (18:90-91, 18:109-10 (Behe); 37:50 (Minnich)). As previously indicated, this argument is merely a restatement of the Reverend William Paley's argument applied at the cell level. Minnich, Behe, and Paley reach the same conclusion, that complex organisms must have been designed using the same reasoning, except that Professors Behe and Minnich refuse to identify the designer, whereas Paley inferred from the presence of design that it was God. (1:6- 7 (Miller); 38:44, 57 (Minnich)). Expert testimony revealed that this inductive argument is not scientific and as admitted by Professor Behe, can never be ruled out. (2:40 (Miller); 22:101 (Behe); 3:99 (Miller))." (Pages 79–80)

Chapter- 3

Specified Complexity

Specified complexity is an argument proposed by William Dembski and used by him and others to promote intelligent design. According to Dembski, the concept is intended to formalize a property that singles out patterns that are both specified and complex. Dembski states that specified complexity is a reliable marker of design by an intelligent agent, a central tenet to intelligent design which Dembski argues for in opposition to modern evolutionary theory. The concept of specified complexity is widely regarded as mathematically unsound and has not been the basis for further independent work in information theory, complexity theory, or biology. Specified complexity is one of the two main arguments used by intelligent design proponents, the other being irreducible complexity.

In Dembski's terminology, a specified pattern is one that admits short descriptions, whereas a complex pattern is one that is unlikely to occur by chance. Dembski argues that it is impossible for specified complexity to exist in patterns displayed by configurations formed by unguided processes. Therefore, Dembski argues, the fact that specified complex patterns can be found in living things indicates some kind of guidance in their formation, which is indicative of intelligence. Dembski further argues that one can rigorously show by applying no free lunch theorems the inability of evolutionary algorithms to select or generate configurations of high specified complexity.

In intelligent design literature, an intelligent agent is one that chooses between different possibilities and has, by supernatural means and methods, caused life to arise. Specified complexity is what Dembski terms an "explanatory filter" which can recognize design by detecting complex specified information (CSI). The filter is based on the premise that the categories of regularity, chance, and design are, according to Dembski, "mutually exclusive and exhaustive." Complex specified information detects design because it detects what characterizes intelligent agency; it detects the actualization of one among many competing possibilities.

A study by Wesley Elsberry and Jeffrey Shallit states that "Dembski's work is riddled with inconsistencies, equivocation, flawed use of mathematics, poor scholarship, and misrepresentation of others' results". Another objection concerns Dembski's calculation of probabilities. According to Martin Nowak, a Harvard professor of mathematics and evolutionary biology "We cannot calculate the probability that an eye came about. We

don't have the information to make the calculation". Critics also reject applying specified complexity to infer design as an argument from ignorance.

Definition

Orgel's original use

The term "specified complexity" was originally coined by origin of life researcher Leslie Orgel to denote what distinguishes living things from non-living things:

In brief, living organisms are distinguished by their *specified* complexity. Crystals are usually taken as the prototypes of simple well-specified structures, because they consist of a very large number of identical molecules packed together in a uniform way. Lumps of granite or random mixtures of polymers are examples of structures that are complex but not specified. The crystals fail to qualify as living because they lack complexity; the mixtures of polymers fail to qualify because they lack specificity.

The term was later employed by physicist Paul Davies in a similar manner:

Living organisms are mysterious not for their complexity per se, but for their tightly specified complexity

Dembski's definition

For Dembski, specified complexity is a property which can be observed in living things. However, whereas Orgel used the term for that which, in Darwinian theory, is understood to be created through evolution, Dembski uses it for that which he says cannot be created through "undirected" evolution—and concludes that it allows one to infer intelligent design. While Orgel employed the concept in a qualitative way, Dembski's use is intended to be quantitative. Dembski's use of the concept dates to his 1998 monograph *The Design Inference*. Specified complexity is fundamental to his approach to intelligent design, and each of his subsequent books has also dealt significantly with the concept. He has stated that, in his opinion, "if there is a way to detect design, specified complexity is it."

Dembski asserts that specified complexity is present in a configuration when it can be described by a pattern that displays a large amount of independently specified information and is also complex, which he defines as having a low probability of occurrence. He provides the following examples to demonstrate the concept: "A single letter of the alphabet is specified without being complex. A long sentence of random letters is complex without being specified. A Shakespearean sonnet is both complex and specified."

In his earlier papers Dembski defined *complex specified information* (CSI) as being present in a specified event whose probability did not exceed 1 in 10^{150}, which he calls the universal probability bound. In that context, "specified" meant what in later work he

called "pre-specified", that is specified before any information about the outcome is known. The value of the universal probability bound corresponds to the inverse of the upper limit of "the total number of [possible] specified events throughout cosmic history," as calculated by Dembski. Anything below this bound has CSI. The terms "specified complexity" and "complex specified information" are used interchangeably. In more recent papers Dembski has redefined the universal probability bound, with reference to another number, corresponding to the total number of bit operations that could possibly have been performed in the entire history of the universe.

Dembski asserts that CSI exists in numerous features of living things, such as DNA and other functional biological molecules, and argues that it cannot be generated by the only known natural mechanisms of physical law and chance, or by their combination. He argues that this is so because laws can only shift around or lose information, but do not produce it, and chance can produce complex unspecified information, or simple specified information, but not CSI; he provides a mathematical analysis that he claims demonstrates that law and chance working together cannot generate CSI, either. Moreover, he claims that CSI is holistic, with the whole being greater than the sum of the parts, and that this decisively eliminates Darwinian evolution as a possible means of its creation. Dembski maintains that by process of elimination, CSI is best explained as being due to intelligence, and is therefore a reliable indicator of design.

Law of conservation of information

Dembski formulates and proposes a law of conservation of information as follows:

This strong proscriptive claim, that natural causes can only transmit CSI but never originate it, I call the Law of Conservation of Information. Immediate corollaries of the proposed law are the following:

1. The specified complexity in a closed system of natural causes remains constant or decreases.
2. The specified complexity cannot be generated spontaneously, originate endogenously or organize itself (as these terms are used in origins-of-life research).
3. The specified complexity in a closed system of natural causes either has been in the system eternally or was at some point added exogenously (implying that the system, though now closed, was not always closed).
4. In particular any closed system of natural causes that is also of finite duration received whatever specified complexity it contains before it became a closed system.

Dembski notes that the term "Law of Conservation of Information" was previously used by Peter Medawar in his book *The Limits of Science* (1984) "to describe the weaker claim that deterministic laws cannot produce novel information." The actual validity and utility of Dembski's proposed law are uncertain; it is neither widely used by the scientific community nor cited in mainstream scientific literature. A 2002 essay by Erik Tellgren

provided a mathematical rebuttal of Dembski's law and concludes that it is "mathematically unsubstantiated."

Specificity

In a more recent paper, Dembski provides an account which he claims is simpler and adheres more closely to the theory of statistical hypothesis testing as formulated by Ronald Fisher. In general terms, Dembski proposes to view design inference as a statistical test to reject a chance hypothesis P on a space of outcomes Ω.

Dembski's proposed test is based on the Kolmogorov complexity of a pattern *T* that is exhibited by an event *E* that has occurred. Mathematically, *E* is a subset of Ω, the pattern *T* specifies a set of outcomes in Ω and *E* is a subset of *T*. Quoting Dembski

Thus, the event *E* might be a die toss that lands six and *T* might be the composite event consisting of all die tosses that land on an even face.

Kolmogorov complexity provides a measure of the computational resources needed to specify a pattern (such as a DNA sequence or a sequence of alphabetic characters). Given a pattern *T*, the number of other patterns may have Kolmogorov complexity no larger than that of *T* is denoted by φ(*T*). The number φ(*T*) thus provides a ranking of patterns from the simplest to the most complex. For example, for a pattern *T* which describes the bacterial flagellum, Dembski claims to obtain the upper bound $\varphi(T) \leq 10^{20}$.

Dembski defines **specified complexity** of the pattern *T* under the chance hypothesis P as

$$\sigma = -\log_2[R \times \varphi(T) \times \mathrm{P}(T)],$$

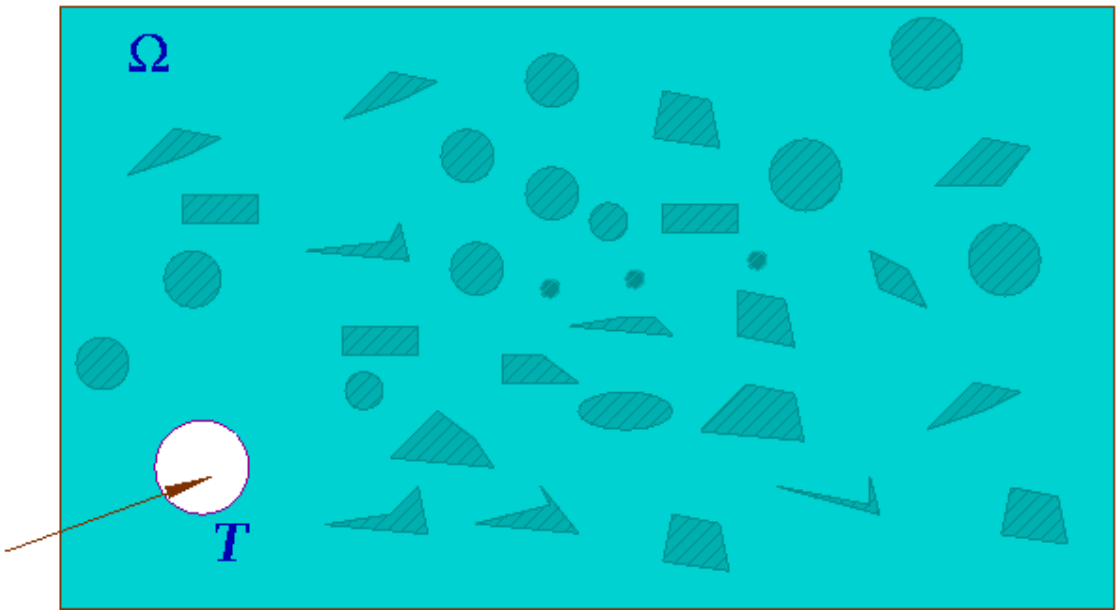
where P(*T*) is the probability of observing the pattern *T*, *R* is the number of "replicational resources" available "to witnessing agents". *R* corresponds roughly to repeated attempts to create and discern a pattern. Dembski then asserts that *R* can be bounded by 10^{120}. This number is supposedly justified by a result of Seth Lloyd in which he determines that the number of elementary logic operations that can have performed in the universe over its entire history cannot exceed 10^{120} operations on 10^{90} bits.

Dembski's main claim is that the following test can be used to infer design for a configuration: There is a target pattern *T* that applies to the configuration and whose specified complexity exceeds 1. This condition can be restated as the inequality

$$10^{120} \times \varphi(T) \times \mathrm{P}(T) < \frac{1}{2}.$$

Dembski's explanation of specified complexity

Dembski's expression σ is unrelated to any known concept in information theory, though he claims he can justify its relevance as follows: An intelligent agent *S* witnesses an event *E* and assigns it to some reference class of events Ω and within this reference class considers it as satisfying a specification *T*. Now consider the quantity $\varphi(T) \times P(T)$ (where P is the "chance" hypothesis):



Possible targets with complexity ranking and probability not exceeding those of attained target *T*. Probability of set-theoretic union does not exceed $\varphi(T) \times P(T)$

Think of S as trying to determine whether an archer, who has just shot an arrow at a large wall, happened to hit a tiny target on that wall by chance. The arrow, let us say, is indeed sticking squarely in this tiny target. The problem, however, is that there are lots of other tiny targets on the wall. Once all those other targets are factored in, is it still unlikely that the archer could have hit any of them by chance?

In addition, we need to factor in what I call the replicational resources associated with *T*, that is, all the opportunities to bring about an event of *T*'s descriptive complexity and improbability by multiple agents witnessing multiple events.

According to Dembski, the number of such "replicational resources" can be bounded by "the maximal number of bit operations that the known, observable universe could have performed throughout its entire multi-billion year history", which according to Lloyd is 10^{120}.

However, according to Elsberry and Shallit, "[specified complexity] has not been defined formally in any reputable peer-reviewed mathematical journal, nor (to the best of our knowledge) adopted by any researcher in information theory."

Calculation of specified complexity

Thus far, Dembski's only attempt at calculating the specified complexity of a naturally occurring biological structure is in his book *No Free Lunch*, for the bacterial flagellum of E. coli. This structure can be described by the pattern "bidirectional rotary motor-driven propeller". Dembski estimates that there are at most 10^{20} patterns described by four basic concepts or fewer, and so his test for design will apply if

$$\mathrm{P}(T) < \frac{1}{2} \times 10^{-140}.$$

However, Dembski says that the precise calculation of the relevant probability "has yet to be done", although he also claims that some methods for calculating these probabilities "are now in place".

These methods assume that all of the constituent parts of the flagellum must have been generated completely at random, a scenario that biologists do not seriously consider. He justifies this approach by appealing to Michael Behe's concept of "irreducible complexity" (IC), which leads him to assume that the flagellum could not come about by any gradual or step-wise process. The validity of Dembski's particular calculation is thus wholly dependent on Behe's IC concept, and therefore susceptible to its criticisms, of which there are many.

To arrive at the ranking upper bound of 10^{20} patterns, Dembski considers a specification pattern for the flagellum defined by the (natural language) predicate "bidirectional rotary motor-driven propeller", which he regards as being determined by four independently chosen basic concepts. He furthermore assumes that English has the capability to express at most 10^5 basic concepts (an upper bound on the size of a dictionary). Dembski then claims that we can obtain the rough upper bound of

$$10^{20} = 10^5 \times 10^5 \times 10^5 \times 10^5$$

for the set of patterns described by four basic concepts or fewer.

From the standpoint of Kolmogorov complexity theory, this calculation is problematic. Quoting Ellsberry and Shallit "Natural language specification without restriction, as Dembski tacitly permits, seems problematic. For one thing, it results in the Berry paradox". These authors add: "We have no objection to natural language specifications per se, provided there is some evident way to translate them to Dembski's formal framework. But what, precisely, is the space of events Ω here?"

Criticisms

The soundness of Dembski's concept of specified complexity and the validity of arguments based on this concept are widely disputed. A frequent criticism is that

Dembski has used the terms "complexity", "information" and "improbability" interchangeably. These numbers measure properties of things of different types: Complexity measures how hard it is to describe an object (such as a bitstring), information measures how close to uniform a random probability distribution is and improbability measures how unlikely an event is given a probability distribution.

When Dembski's mathematical claims on specific complexity are interpreted to make them meaningful and conform to minimal standards of mathematical usage, they usually turn out to be false. Dembski often sidesteps these criticisms by responding that he is not "in the business of offering a strict mathematical proof for the inability of material mechanisms to generate specified complexity". Yet on page 150 of *No Free Lunch* he claims he can prove his thesis mathematically: *"In this section I will present an in-principle mathematical argument for why natural causes are incapable of generating complex specified information."* Others have pointed out that a crucial calculation on page 297 of *No Free Lunch* is off by a factor of approximately 10^{65}.

Dembski's calculations show how a simple smooth function cannot gain information. He therefore concludes that there must be a designer to obtain CSI. However, natural selection has a branching mapping from one to many (replication) followed by pruning mapping of the many back down to a few (selection). When information is replicated, some copies can be differently modified while others remain the same, allowing information to increase. These increasing and reductional mappings were not modeled by Dembski. In other words, Dembski's calculations do not model birth and death. This basic flaw in his modeling renders all of Dembski's subsequent calculations and reasoning in *No Free Lunch* irrelevant because his basic model does not reflect reality. Since the basis of *No Free Lunch* relies on this flawed argument, the entire thesis of the book collapses.

According to Martin Nowak, a Harvard professor of mathematics and evolutionary biology "We cannot calculate the probability that an eye came about. We don't have the information to make the calculation".

Dembski's critics note that specified complexity, as originally defined by Leslie Orgel, is precisely what Darwinian evolution is supposed to create. Critics maintain that Dembski uses "complex" as most people would use "absurdly improbable". They also claim that his argument is a tautology: CSI cannot occur naturally because Dembski has defined it thus. They argue that to successfully demonstrate the existence of CSI, it would be necessary to show that some biological feature undoubtedly has an extremely low probability of occurring by any natural means whatsoever, something which Dembski and others have almost never attempted to do. Such calculations depend on the accurate assessment of numerous contributing probabilities, the determination of which is often necessarily subjective. Hence, CSI can at most provide a "very high probability", but not absolute certainty.

Another criticism refers to the problem of "arbitrary but specific outcomes". For example, if a coin is tossed randomly 1000 times, the probability of any particular outcome

occurring is roughly one in 10^{300}. For any particular specific outcome of the coin-tossing process, the *a priori* probability that this pattern occurred is thus one in 10^{300}, which is astronomically smaller than Dembski's universal probability bound of one in 10^{150}. Yet we know that the *post hoc* probability of its happening is exactly one, since we observed it happening. This is similar to the observation that it is unlikely that any given person will win a lottery, but, eventually, a lottery will have a winner; to argue that it is very unlikely that any one player would win is not the same as proving that there is the same chance that no one will win. Similarly, it has been argued that "a space of possibilities is merely being explored, and we, as pattern-seeking animals, are merely imposing patterns, and therefore targets, after the fact."

Apart from such theoretical considerations, critics cite reports of evidence of the kind of evolutionary "spontanteous generation" that Dembski claims is too improbable to occur naturally. For example, in 1982, B.G. Hall published research demonstrating that after removing a gene that allows sugar digestion in certain bacteria, those bacteria, when grown in media rich in sugar, rapidly evolve new sugar-digesting enzymes to replace those removed. Another widely cited example is the discovery of nylon eating bacteria that produce enzymes only useful for digesting synthetic materials that did not exist prior to the invention of nylon in 1935.

Other commentators have noted that evolution through selection is frequently used to design certain electronic, aeronautic and automotive systems which are considered problems too complex for human "intelligent designers". This strongly contradicts the argument that an intelligent designer is required for the most complex systems. Such evolutionary techniques can lead to designs that are difficult to understand or evaluate since no human understands which trade-offs were made in the evolutionary process, something which mimics our poor understanding of biological systems.

Dembski's book *No Free Lunch* was criticised for not addressing the work of researchers who use computer simulations to investigate artificial life. According to Jeffrey Shallit:

The field of artificial life evidently poses a significant challenge to Dembski's claims about the failure of evolutionary algorithms to generate complexity. Indeed, artificial life researchers regularly find their simulations of evolution producing the sorts of novelties and increased complexity that Dembski claims are impossible.

Chapter- 4

Intelligent Designer

An **intelligent designer**, also referred to as an **intelligent agent**, is the hypothetical willed and self-conscious entity that the intelligent design movement argues had some role in the origin and/or development of life and who supposedly has left scientific evidence of this intelligent design. They also use the term "intelligent cause" implying their teleological supposition of direction and purpose in features of the universe and of living things.

History

Many metaphysical views take the stance that life and/or the universe owes its structure to an intelligent design. Atheist Richard Dawkins holds that "It's possible that you might find evidence if you look at the details of biochemistry, molecular biology, you might find a signature of some sort of designer". However, the popularly termed intelligent design movement is a neo-creationist campaign that arose out of the previous Christian fundamentalist and evangelistic creation science movement. Proponents of intelligent design argue to the public that their concept does not posit the identity of the designer as part of this effort. But in statements to their constituency, which consists largely of Christian conservatives, they identify the designer as God.

Who does the ID movement think the designer is?

William Dembski states in his book *Design Inference* that the nature of the intelligent designer cannot be inferred from intelligent design and suggests that the designer, if one is even necessary for design inference, may or may not be "the God of Scripture." In December 2007 Dembski told Focus on the Family, "I believe God created the world for a purpose. The Designer of intelligent design is, ultimately, the Christian God." Some leading intelligent design proponents have stated identifying or characterizing the designer is beyond the scope of intelligent design as a line of inquiry. Proponents had hoped that, by avoiding invoking creation by a specific supernatural entity, (such as that employed by creation science), intelligent design would be considered scientific and not violate the establishment clause of the US constitution. Proponents feared that were intelligent design identified as a restatement of previous forms of creationism, it would be precluded from being taught in public schools after the 1987 Supreme Court of the United States decision in *Edwards vs Aguillard*. This line of reasoning was not

particularly persuasive to many in the scientific community, which largely rejected intelligent design as both a line of scientific inquiry and as a basis for a sound education in science.

On December 20, 2005 federal district court ruled in *Kitzmiller v. Dover Area School District* that intelligent design was not science and was essentially religious in nature. The ruling not only rendered that public school district's requirement endorsing intelligent design as an alternative to evolution in science classes unconstitutional on the grounds that its inclusion violates the Establishment Clause of the First Amendment, but validated the objections of critics who discounted proponent's claim that the identity was not God.

Highlighting these mutually exclusive claims about the designer, Dembski, despite having said that the intelligent designer or designers could be any god or gods, or even space aliens, has also said that "intelligent design should be understood as the evidence that God has placed in nature to show that the physical world is the product of intelligence and not simply the result of mindless material forces" and that "Intelligent design is just the Logos theology of John's Gospel restated in the idiom of information theory."

Michael Behe, in his book Darwin's Black Box, suggested the designer might be a time traveling cell biologist.

At various times, leading proponents in the intelligent design movement have clearly expressed that they consider the Abrahamic God "Elohim" in his role as a creator God, to be the intelligent designer and denied that intelligent designer is God, depending on which audience they are addressing. One example is William Dembski, who on his blog in response to the question "Is the designer responsible for biological complexity God?" said "not necessarily" and "To ask who or what is the designer of a particular object is to ask for the immediate intelligent agent responsible for its design. The point is that God is able to work through derived or surrogate intelligences, which can be anything from angels to organizing principles embedded in nature." Yet to the intelligent design movement's conservative Christian constituents Dembski has said "intelligent design should be understood as the evidence that God has placed in nature to show that the physical world is the product of intelligence and not simply the result of mindless material forces. This evidence is available to all apart from the special revelation of God in salvation history as recounted in Scripture. ... Intelligent design makes it impossible to be an intellectually fulfilled atheist. This gives intelligent design incredible traction as a tool for apologetics, opening up the God-question to individuals who think that science has buried God" and "Thus, in its relation to Christianity, intelligent design should be viewed as a ground-clearing operation that gets rid of the intellectual rubbish that for generations has kept Christianity from receiving serious consideration." Stephen C. Meyer, founder and leader of the intelligent design program of the Discovery Institute admitted on national television he believes that the designer is God.

In addition, the intelligent design movement seeks as a well-documented agenda the overall goal "to defeat materialism" and the "materialist world view" as represented by evolution, and replace it with "a science consonant with Christian and theistic convictions." Phillip E. Johnson, considered the father of the ID movement has stated that the goal of intelligent design is to cast creationism as a scientific concept:

"Our strategy has been to change the subject a bit so that we can get the issue of intelligent design, which really means the reality of God, before the academic world and into the schools." -- *Phillip E. Johnson, American Family Radio, January 10, 2003*

"This isn't really, and never has been a debate about science. It's about religion and philosophy." -- *Phillip E. Johnson, World Magazine, November 30, 1996*

The Discovery Institute's leaked Wedge document sets out the movement's governing goals, including:

"To replace materialistic explanations with the theistic understanding that nature and human beings are created by God." . . . "Design theory promises to reverse the stifling dominance of the materialist worldview, and to replace it with a science consonant with Christian and theistic convictions." -- *The Wedge Document, a 1999 Discovery Institute pamphlet*

What does the ID movement think the designer did?

Opinion as to the amount of creation the intelligent designer has done varies within the ID movement. Michael Behe's concept of irreducible complexity has natural selection accounting for most of evolution but the intelligent designer contributing the design of some proteins. Others in the ID movement however contest concepts such as common descent, particularly of humans and other apes. Though most in the ID movement seem to be Old Earth Creationists, a few are Young Earth Creationists who believe in ex-nihilo.

The amount of creation that the intelligent designer did has also been criticised by Young Earth Creationists as not being specific enough, and particularly contradicting their beliefs of Biblical inerrancy and a young earth.

Some intelligent design proponents say the intelligent designer fine-tuned the universe's physical constants in such a way that life is the result of the universe's physical constants being related to one another in a fashion that permits life to exist. The fine-tuned universe argument is a central premise or presented as a given in many of the published works of prominent intelligent design proponents, such as William A. Dembski and Michael Behe.

Criticism

Intelligent design has been presented by its proponents as a "big tent" strategy into which several accounts of creation can fit. Were a "scientific" version of intelligent design

approved for inclusion in public school science curricula, then a path would be opened for discussion of alternatives to not only natural selection but naturalism as well, and eventually religious accounts on the origin of life. The vast majority of scientists reject the concept of intelligent design and an intelligent designer. Instead, the most widely accepted explanation is that physical processes such as natural selection can account for the complexity of life and other phenomena and features of the universe. Attempts to insert theories of intelligent design into public school science curricula fits in with the intelligent design movement's social aims, via the overturning of Western secularism as detailed in the Wedge strategy. The concept of the intelligent designer has been criticised as a God-of-the-gaps argument. Introducing the hypothesis of an intelligent designer introduces the unsolved problem of accounting for the origin of such a designer (first cause).

By raising the question of the need for a designer for objects with irreducible complexity, intelligent design also raises the question, "what designed the designer?" Richard Dawkins has argued that "If complex organisms demand an explanation, so does a complex designer. And it's no solution to raise the theologian's plea that God (or the intelligent designer) is simply immune to the normal demands of scientific explanation," since such an answer would be unscientific. With religious creationism, the question "what created God?" can be answered with theological arguments, but in intelligent design, the chain of designers can be followed back indefinitely in an infinite regression, leaving the question of the creation of the first designer dangling. As a result, intelligent design does not explain how the complexity happened in the first place; it just moves it.

Elliott Sober says that by intelligent design's own arguments, a designer capable of creating irreducible complexity must also be irreducibly complex: "Any mind in nature that designs and builds an irreducibly complex system is itself irreducibly complex" Sober says that this an argument that intelligent design proponents still need to respond to.

If intelligent design proponents invoke an uncaused causer or deity to resolve this problem, they contradict a fundamental assumption of intelligent design that design requires a designer and reduce intelligent design to religious creationism. Another possible counter-argument might be an infinite regression of designers. However, admitting infinite numbers of objects also allows any arbitrarily improbable event to occur, such as an object with "specific" complexity assembling itself by chance. Again, this contradicts a fundamental assumption of intelligent design that a designer is needed for every specifically complex object, producing a logical contradiction.

Critics contend the claim that positing a designer which explains gaps in our understanding yet does not need to be itself explained as not a contribution to knowledge but as a thought-terminating cliché.

The Dover trial

In 2005, intelligent design proponents arguments regarding the identity of a designer became an issue considered by the court in *Kitzmiller v. Dover Area School District*, the "Dover trial," where plaintiffs successfully argued that intelligent design is a form of creationism, and that the school board policy requiring the presentation of intelligent design as an alternative to evolution as an "explanation of the origin of life" thus violated the Establishment Clause of the First Amendment to the United States Constitution. In his ruling, the judge stated

"However, as Dr. Haught testified, anyone familiar with Western religious thought would immediately make the association that the tactically unnamed designer is God..." -- *Ruling, Kitzmiller v. Dover Area School District, page 25*

Jones also commented that the appearance of design is subjective,

"It is readily apparent to the Court that the only attribute of design that biological systems appear to share with human artifacts is their complex appearance, i.e. if it looks complex or designed, it must have been designed. (23:73 (Behe)). This inference to design based upon the appearance of a "purposeful arrangement of parts" is a completely subjective proposition, determined in the eye of each beholder and his/her viewpoint concerning the complexity of a system." -- *Ruling, Kitzmiller v. Dover Area School District, page 81*

and thus the analogy upon which the argument from design rests is flawed.

"For human artifacts, we know the designer's identity, human, and the mechanism of design, as we have experience based upon empirical evidence that humans can make such things, as well as many other attributes including the designer's abilities, needs, and desires. With ID, proponents assert that they refuse to propose hypotheses on the designer's identity, do not propose a mechanism, and the designer, he/she/it/they, has never been seen. In that vein, defense expert Professor Minnich agreed that in the case of human artifacts and objects, we know the identity and capacities of the human designer, but we do not know any of those attributes for the designer of biological life. In addition, Professor Behe agreed that for the design of human artifacts, we know the designer and its attributes and we have a baseline for human design that does not exist for design of biological systems. Professor Behe's only response to these seemingly insurmountable points of disanalogy was that the inference still works in science fiction movies. -- *Ruling, Kitzmiller v. Dover Area School District, page 81*

The judge ruled that "ID cannot uncouple itself from its creationist, and thus religious, antecedents" and "that ID is an interesting theological argument, but that it is not science."

Chapter- 5

Intelligent Design Movement

The **intelligent design movement** is a neo-creationist religious campaign for broad social, academic and political change to promote and support the idea of "intelligent design," which asserts that "certain features of the universe and of living things are best explained by an intelligent cause, not a possibly undirected process such as natural selection." Its chief activities are a campaign to promote public awareness of this concept, the lobbying of policymakers to include its teaching in high school science classes, and legal action, either to defend such teaching or to remove barriers otherwise preventing it. The movement arose out of the previous Christian fundamentalist and evangelistic creation science movement in the United States, and is driven by a small group of proponents.

The overall goal of the intelligent design movement is to "overthrow materialism" and atheism. Its proponents believe that society has suffered "devastating cultural consequences" from adopting materialism and that science is the cause of the decay into materialism because it seeks only natural explanations, and is therefore atheistic. They believe that the theory of evolution implies that humans have no spiritual nature, no moral purpose, and no intrinsic meaning. They seek to "defeat [the] materialist world view" represented by the theory of evolution in favor of "a science consonant with Christian and theistic convictions".

To achieve their goal of defeating a materialistic world view, advocates of intelligent design take a two-pronged approach. Alongside the promotion of intelligent design, proponents also seek to "Teach the Controversy"; discredit evolution by emphasizing perceived flaws in the theory of evolution, or disagreements within the scientific community and encourage teachers and students to explore non-scientific alternatives to evolution, or to critically analyze evolution and the controversy surrounding the teaching of evolution. But the world's largest general scientific society, the American Association for the Advancement of Science, has stated that "There is no significant controversy within the scientific community about the validity of evolution." and that "Evolution is one of the most robust and widely accepted principles of modern science." The ruling in the Dover trial, Kitzmiller v. Dover Area School District, where the claims of intelligent design proponents were considered by a United States federal court, stated that "evolution, including common descent and natural selection, is 'overwhelmingly accepted' by the scientific community."

The Discovery Institute is a conservative Christian think tank that drives the intelligent design movement. The Institute's Center for Science and Culture (CSC) counts most of the leading intelligent design advocates among its membership, most notably its program advisor Phillip E. Johnson. Johnson is the architect of the movement's key strategies, the "wedge strategy" and the *Teach the Controversy* campaign.

The Discovery Institute and leading proponents represent intelligent design as a revolutionary scientific theory. The overwhelming majority of the scientific community, as represented by the American Association for the Advancement of Science, the National Academy of Sciences and nearly all scientific professional organizations, firmly rejects these claims, and insist that intelligent design is not valid science, its proponents having failed to conduct an actual scientific research program. This has led the movement's critics to state that intelligent design is merely a public relations campaign and a political campaign.

According to critics of the intelligent design movement, the movement's purpose is political rather than scientific or educational. They claim the movement's "activities betray an aggressive, systematic agenda for promoting not only intelligent design creationism, but the religious worldview that undergirds it." Intelligent design is an attempt to recast religious dogma in an effort to reintroduce the teaching of biblical creationism to public school science classrooms; the intelligent design movement is an effort to reshape American society into a theocracy, primarily through education. As evidence, critics cite the Discovery Institute's political activities, its "Wedge strategy" and statements made by leading intelligent design proponents.

The scientific community's position, as represented by the National Academy of Sciences and the National Center for Science Education, is that intelligent design is not science, but creationist pseudoscience. Richard Dawkins, a biologist and professor at Oxford University, compares the intelligent design movement's demand to "teach the controversy" with the demand to teach flat earthism; acceptable in terms of history, but not in terms of science. "If you give the idea that there are two schools of thought within science, one that says the earth is round and one that says the earth is flat, you are misleading children."

Philosophy

At the 1999 "Reclaiming America for Christ Conference" called by Reverend D. James Kennedy of Coral Ridge Ministries, Johnson gave a speech called *How the Evolution Debate Can Be Won.* In it he sums up the theological and epistemological underpinnings of intelligent design and its strategy for winning the battle:

"To talk of a purposeful or guided evolution is not to talk about evolution at all. That is slow creation. When you understand it that way, you realize that the Darwinian theory of evolution contradicts not just the Book of Genesis, but every word in the Bible from beginning to end. It contradicts the idea that we are here because a creator brought about

our existence for a purpose. That is the first thing I realized, and it carries tremendous meaning." -- *Phillip Johnson*

"I have built an intellectual movement in the universities and churches that we call The Wedge, which is devoted to scholarship and writing that furthers this program of questioning the materialistic basis of science. One very famous book that's come out of The Wedge is biochemist Michael Behe's book, *Darwin's Black Box*, which has had an enormous impact on the scientific world." -- *Phillip Johnson*

"Now the way that I see the logic of our movement going is like this. The first thing you understand is that the Darwinian theory isn't true. It's falsified by all of the evidence and the logic is terrible. When you realize that, the next question that occurs to you is, well, where might you get the truth? When I preach from the Bible, as I often do at churches and on Sundays, I don't start with Genesis. I start with John 1:1. In the beginning was the word. In the beginning was intelligence, purpose, and wisdom. The Bible had that right. And the materialist scientists are deluding themselves." -- *Phillip Johnson*

History of the movement

The intelligent design movement grew out of a creationist tradition which argues against evolutionary theory from a religious standpoint, usually that of evangelical or fundamentalistic Christianity. Although intelligent design advocates often claim that they are arguing only for the existence of a designer who may or may not be God, all the movement's leading advocates believe that this designer is God. They frequently accompany their arguments with a discussion of religious issues, especially when addressing religious audiences, but elsewhere downplay the religious aspects of their agenda.

Origins

The modern use of the words "intelligent design", as a term intended to describe a field of inquiry, began after the Supreme Court of the United States, in the case of *Edwards v. Aguillard* (1987), ruled that creationism is unconstitutional in public school science curricula. A Discovery Institute report says that Charles Thaxton, editor of *Of Pandas and People*, had picked the phrase up from a NASA scientist, and thought "That's just what I need, it's a good engineering term". In drafts of the book over one hundred uses of the root word "creation", such as "creationism" and "creation science", were changed, almost without exception, to "intelligent design", while "creationists" was changed to "design proponents" or, in one instance, "cdesign proponentsists". [*sic*] In 1989 *Of Pandas and People* was published by the Foundation for Thought and Ethics, with the definition:

Intelligent design means that various forms of life began abruptly through an intelligent agency, with their distinctive features already intact. Fish with fins and scales, birds with feathers, beaks, wings, etc.

Pandas was followed in 1991 by *Darwin on Trial*, a neo-creationist polemic by University of California, Berkeley law professor emeritus Phillip E. Johnson, that is regarded as a central text of the movement. *Darwin on Trial* mentioned *Pandas* as "'creationist' only in the sense that it juxtaposes a paradigm of 'intelligent design' with the dominant paradigm of (naturalistic) evolution", but his use of the term as a focus for his wedge strategy promoting "theistic realism" came later. The book was reviewed by evolutionary biologist Stephen Jay Gould for Scientific American in July 1992, concluding that the book contains "...no weighing of evidence, no careful reading of literature on all sides, no full citation of sources and occasional use of scientific literature only to score rhetorical points." This "devastating" review led to the formation in 1992 or 1993 of an 'Ad Hoc Origins Committee' of Johnson's supporters, which wrote a letter, circulated to thousands of university professors, defending the book. Among the 39 signatories were nine who later became members of the Center for the Renewal of Science and Culture.

During the early 1990s Johnson worked to develop a 'big tent' movement to unify a wide range of creationist viewpoints in opposition to evolution. In 1992, the first formal meeting devoted to intelligent design was held in Southern Methodist University. It included a debate between Johnson and Michael Ruse (a key witness in *McLean v. Arkansas*) and papers by William A. Dembski, Michael Behe and Stephen C. Meyer. In 1993 Johnson organized a follow-up meeting, including Dembski, Behe, Meyer, Dean H. Kenyon (co-author of *Pandas*) and Walter Bradley (co-author with Thaxton and Kenyon of *The Mystery of Life's Origin*), as well as two young Earth creationist graduate students, Paul A. Nelson and Jonathan Wells.

Center for the Renewal of Science and Culture

On 6 December 1993 an article by Meyer was published in the *Wall Street Journal*, drawing national attention to the controversy over Kenyon's teaching of creationism. This article also gained the attention of Discovery Institute co-founder Bruce Chapman. On discovering that Meyer was developing the idea of starting a scientific research center in conversations with conservative political scientist John G. West, Chapman invited them to create a unit within the Discovery Institute called the Center for the Renewal of Science and Culture (later renamed the Center for Science and Culture). This center was dedicated to overthrowing "scientific materialism" and "fomenting nothing less than a scientific and cultural revolution". A 1995 conference, on "The Death of Materialism and the Renewal of Culture" served as a blueprint for the center. By 1996 they had nearly a million dollars in grants, the largest being from Howard Ahmanson, Jr., with smaller but still large contributions coming from the Stewardship Foundation established by C. Davis Weyerhaeuser and the Maclellan Foundation, and appointed their first class of research fellows.

The Wedge strategy

The Wedge strategy was formulated by Johnson to combat the "evil" of methodological naturalism. It first came to the general public's attention when a Discovery Institute

internal memo now known as the "Wedge Document" (believed to have been written in 1998) was leaked to the public in 1999. However it is believed to have been update of an earlier document to be implemented between 1996 and 2001.

The document begins with "the proposition that human beings are created in the image of God is one of the bedrock principles on which Western civilization was built." and then goes on to outline the movement's goal to exploit perceived discrepancies within evolutionary theory in order to discredit evolution and scientific materialism in general. Much of the strategy is directed toward the broader public, as opposed to the professional scientific community. The stated "governing goals" of the CSC's wedge strategy are:

1. To defeat scientific materialism and its destructive moral, cultural and political legacies
2. To replace materialistic explanations with the theistic understanding that nature and human beings are created by God.

Critics of intelligent design movement argue that the wedge document and strategy demonstrate that the intelligent design movement is motivated purely by religion and political ideology and that the Discovery Institute as a matter of policy obfuscates its agenda. The Discovery Institute's official response was to characterize the criticism and concern as "irrelevant," "paranoid," and "near-panic" while portraying the wedge document as a "fund-raising document."

Johnson in his 1997 book *Defeating Darwinism by Opening Minds* confirmed some of the concerns voiced by the movement's gainsayers:

"If we understand our own times, we will know that we should affirm the reality of God by challenging the domination of materialism and naturalism in the world of the mind. With the assistance of many friends I have developed a strategy for doing this,...We call our strategy the "wedge." -- *Phillip Johnson*

Kansas evolution hearings

The Kansas evolution hearings were a series of hearings held in Topeka, Kansas, United States May 5 to May 12, 2005 by the Kansas State Board of Education and its State Board Science Hearing Committee to change how evolution and the origin of life would be taught in the state's public high school science classes. The hearings were arranged by the conservative Christian Board of Education with the intent of introducing intelligent design into science classes via the Teach the Controversy method.

The hearings raised the issues of creation and evolution in public education and were attended by all the major participants in the intelligent design movement but were ultimately boycotted by the scientific community over concern of lending credibility to the claim, made by proponents of intelligent design, that evolution is purportedly the subject of wide dispute within the scientific and science education communities.

The Discovery Institute, hub of the intelligent design movement, played a central role in starting the hearings by promoting its Critical Analysis of Evolution lesson plan which the Kansas State Board of Education eventually adopted over objections of the State Board Science Hearing Committee, and campaigning on behalf of conservative Republican candidates for the Board.

Local science advocacy group Kansas Citizens for Science organized a boycott of the hearings by mainstream scientists, who accused it of being a kangaroo court and argued that their participation would lend an undeserved air of legitimacy to the hearings. Board member Kathy Martin declared at the beginning of the hearings "Evolution has been proven false. ID (Intelligent Design) is science-based and strong in facts." At their conclusion she proclaimed that evolution is "an unproven, often disproven" theory.

"ID has theological implications. ID is not strictly Christian, but it is theistic," asserted Martin. The scientific community rejects teaching intelligent design as science; a leading example being the United States National Academy of Sciences, which issued a policy statement saying "Creationism, intelligent design, and other claims of supernatural intervention in the origin of life or of species are not science because they are not testable by the methods of science."

On February 13, 2007, the Board voted 6 to 4 to reject the amended science standards enacted in 2005.

Kitzmiller v. Dover Area School District

In the movement's sole major case, *Kitzmiller v. Dover Area School District*, it was represented by the Thomas More Law Center, which had been seeking a test-case on the issue for at least five years. However conflicting agendas resulted in the withdrawal of a number of Discovery Institute (DI) Fellows as expert witnesses, at the request of DI director Bruce Chapman, and mutual recriminations with the DI after the case was lost. The Alliance Defense Fund briefly represented the Foundation for Thought and Ethics (FTE) in its unsuccessful motion to intervene in this case, and prepared *amicus curiae* briefs on behalf of the DI and FTE in it. It has also made *amicus curiae* submissions and offered to pay for litigation, in other (actual and potential) creationism-related cases. On a far smaller scale, Larry Caldwell and his wife operate under the name Quality Science Education for All, and have made a number of lawsuits in furtherance of the movement's anti-evolution agenda. In 2005 they brought at least three separate lawsuits to further the intelligent design movement's agenda. One was later abandoned, two were dismissed.

Reception by the scientific community

Intelligent design advocates realize that their arguments have little chance of acceptance within the mainstream scientific community, so they direct them toward politicians, philosophers and the general public. What prima facie "scientific" material they have produced has been attacked by critics as containing factual misrepresentation and misleading, rhetorical and equivocal terminology. A number of pseudoscientific

documentaries that present intelligent design as an increasingly well-supported line of scientific inquiry have been made. The bulk of the material produced by the intelligent design movement, however, is not intended to be scientific but rather to promote its social and political aims. Polls indicate that intelligent design's main appeal to citizens comes from its link to religious concepts.

An August 2005 poll from The Pew Forum on Religion & Public Life showed 64% of Americans favoring the teaching of creationism along with evolution in science classrooms, though only 38% favored teaching it instead of evolution, with the results varying deeply by education level and religiosity. The poll showed the educated were far less attached to intelligent design than the less educated. Evangelicals and fundamentalists showed high rates of affiliation with intelligent design while other religious persons and the secular were much lower.

Scientists responding to a poll overwhelmingly said intelligent design is about religion, not science. A 2002 sampling of 460 Ohio science professors had 91% say it's primarily religion, 93% say there is not "any scientifically valid evidence or an alternative scientific theory that challenges the fundamental principle of the theory of evolution," and 97% say that they did not use intelligent design concepts in their own research.

In October and November 2001 the Discovery Institute advertised *A Scientific Dissent From Darwinism* listing what they claimed were "100 scientific dissenters" who had signed a statement that "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." Shortly afterwards the NCSE described the wording as misleading, noting that a minority of the signatories were biologists and some of the others were engineers, mathematicians and philosophers, and that some signatories did not fully support the Discovery Institute's claims. The list was further criticized in a February 2006 New York Times article which pointed out that only 25% of the signatories by then were biologists and that signatories' "doubts about evolution grew out of their religious beliefs." In 2003 as a humorous parody of such listings the NCSE produced the pro-evolution Project Steve list of signatories, all with variations of the name Steve and most of whom are trained biologists. As of July 31, 2006, the Discovery Institute lists "over 600 scientists", while Project Steve reported 749 signatories; as of September 30, 2009, 1,112 Steves have signed the statement.

Structure

The 'big tent' strategy

The movement's strategy as set forth by Johnson states the replacement of "materialist science" with "theistic science" as its primary goal; and, more generally, for intelligent design to become "the dominant perspective in science" and to "permeate our religious, cultural, moral and political life." This agenda is now being actively pursued by the Center for Science and Culture (CSC), which plays the leading role in the promotion of

intelligent design. Its fellows include most of the leading intelligent design advocates: William A. Dembski, Michael Behe, Jonathan Wells and Stephen C. Meyer.

Intelligent design has been described by its proponents as a "big tent" belief, one in which all theists united by a having some kind of creationist belief (but of differing opinions as regards details) can support. If successfully promoted, it would reinstate creationism in the teaching of science, after which debates regarding details could resume. In his 2002 article *Big Tent: Traditional Creationism and the Intelligent Design Community*, Discovery Institute fellow Paul A. Nelson credits Johnson for the "big tent" approach and for reviving creationist debate since the Edwards v. Aguillard decision. According to Nelson, "The promise of the big tent of ID is to provide a setting where Christians and others may disagree amicably and fruitfully about how best to understand the natural world as well as scripture."

In his presentation to the 1999 Reclaiming America for Christ Conference, *How the Evolution Debate can be Won*, Johnson affirmed this "big tent" role for "The Wedge" (without using the term intelligent design):

To talk of a purposeful or guided evolution is not to talk about evolution at all. That is "slow creation." When you understand it that way, you realize that the Darwinian theory of evolution contradicts not just the book of Genesis, but every word in the Bible from beginning to end. It contradicts the idea that we are here because a Creator brought about our existence for a purpose. That is the first thing I realized, and it carries tremendous meaning. [...]

So did God create us? Or did we create God? That's an issue that unites people across the theistic world. Even religious, God-believing Jewish people will say, "That's an issue we really have a stake in, so let's debate that question first. Let us settle that question first. There are plenty of other important questions on which we may not agree, and we'll have a wonderful time discussing those questions after we've settled the first one. We will approach those questions in a better spirit because we have worked together for this important common end." [...]

[The Wedge is] inherently an ecumenical movement. Michael Behe is a Roman Catholic. The next book that is coming out from Cambridge University Press by one of my close associates is by an evangelical convert to Greek Orthodoxy. We have a lot of Protestants, too. The point is that we have this broad-based intellectual movement that is enabling us to get a foothold in the scientific and academic journals and in the journals of the various religious faiths.

– Phillip Johnson, The Evolution Debate Can Be Won

The Discovery Institute consistently denies allegations that its intelligent design agenda has religious foundations, and downplays the religious source of much of its funding. In an interview of Stephen C. Meyer when ABC News'asked about the Discovery Institute's

many evangelical Christian donors the institute's public relations representative stopped the interview saying "I don't think we want to go down that path."

Obfuscation of religious motivation

Phillip E. Johnson, largely regarded as the leader of the movement, positions himself as a "theistic realist" against "methodological naturalism" and intelligent design as the method through which God created life. Johnson explicitly calls for intelligent design proponents to obfuscate their religious motivations so as to avoid having intelligent design recognized "as just another way of packaging the Christian evangelical message." Hence intelligent design arguments are carefully formulated in secular terms and intentionally avoid positing the identity of the designer. Johnson has stated that cultivating ambiguity by employing secular language in arguments which are carefully crafted to avoid overtones of theistic creationism is a necessary first step for ultimately introducing the Christian concept of God as the designer. Johnson emphasizes "the first thing that has to be done is to get the Bible out of the discussion" and that "after we have separated materialist prejudice from scientific fact" only then can "biblical issues" be discussed. In the foreword to *Creation, Evolution, & Modern Science* (2000) Johnson writes "The intelligent design movement starts with the recognition that 'In the beginning was the Word.' and 'In the beginning God created.' Establishing that point isn't enough, but it is absolutely essential to the rest of the gospel message."

Organizations

The Center for Science and Culture

The Center for Science and Culture (CSC), formerly known as the Center for Renewal of Science and Culture (CRSC), is a division of the Discovery Institute. The Center consists of a tightly knit core of people who have worked together for almost a decade to advance intelligent design as both a concept and a movement as necessary adjuncts of its wedge strategy policy. This cadre includes Phillip E. Johnson, Michael Behe, William A. Dembski and Stephen C. Meyer. They are united by a religious vision which, although it varies among the members in its particulars and is seldom acknowledged outside of the Christian press, is predicated on the shared conviction that America is in need of "renewal" which can be accomplished only by unseating "Godless" materialism and instituting religion as its cultural foundation.

In his keynote address at the "Research and Progress in intelligent design" (RAPID) conference held in 2002 at Biola University, William A. Dembski described intelligent design's "dual role as a constructive scientific project and as a means for cultural renaissance." In a similar vein, the movement's hub, the Discovery Institute's Center for Science and Culture had until 2002 been the "*Center for the Renewal of Science and Culture*". Explaining the name change, a spokesperson for the CSC insisted that the old name was simply too long. However, the change followed accusations that the center's real interest was not science but reforming culture along lines favored by conservative Christians.

Critics of the movement cite the Wedge Document as confirmation of this criticism and assert that the movement's leaders, particularly Phillip E. Johnson, view the subject as a culture war: "*Darwinian evolution is not primarily important as a scientific theory but as a culturally dominant creation story ... When there is radical disagreement in a commonwealth about the creation story, the stage is set for intense conflict, the kind ... known as 'culture war.'* "

Recently the Center for Science and Culture's has moderated its previous overtly theistic mission statements to appeal to a broader, a more secular audience. It hopes to accomplish this by using less overtly theistic messages and language. Despite this, the Center for Science and Culture still states as a goal a redefinition of science, and the philosophy on which it is based, particularly the exclusion of what it calls the "unscientific principle of materialism", and in particular the acceptance of what it calls "the scientific theory of intelligent design".

According to Reason magazine, promotional materials from the Discovery Institute acknowledge that the Ahmanson family donated $1.5 million to the Center for Science and Culture, then known as the Center for Renewal of Science and Culture, for a research and publicity program to "unseat not just Darwinism but also Darwinism's cultural legacy". Mr. Ahmanson funds many causes important to the Christian religious right, including Christian Reconstructionism, whose goal is to place the U.S. "under the control of biblical law." Until 1995, Ahmanson sat on the board of the Christian reconstructionist Chalcedon Foundation.

Other organizations

- The Access Research Network (ARN), has become a comprehensive clearinghouse for ID resources, including news releases, publications, multimedia products and an elementary school science curriculum. It's stated mission is "providing accessible information on science, technology and society issues from an intelligent design perspective." Its directors are Dennis Wagner and CSC Fellows Mark Hartwig, Stephen C. Meyer and Paul Nelson. Its 'Friends of ARN' is also dominated by CSC Fellows.
- The Intelligent Design and Evolution Awareness Center (IDEA Center) is a Christian nonprofit organization formed originally as a student club promoting intelligent design at the University of California, San Diego (UCSD). There are about 25 active chapters of this organization in the United States, Kenya, Canada, Ukraine, and The Philippines. There have been a total of 35 active chapters formed and several others are currently pending. Six out of the listed 32 chapters in the USA are located at high schools In December 2008, biologist Allen MacNeill stated, on the basis of analysis of the webpages of the national organization and local chapters, that it appeared that the organization is moribund.
- The Intelligent Design Network (IDnet) is a nonprofit organization formed in Kansas to promote intelligent design. It is based in Shawnee Mission, Kansas. The Intelligent Design Network was founded by John Calvert, a corporate finance lawyer with a bachelor's degree in geology and nutritionist William S. Harris.

Together, Calvert and Harris have published the article "Intelligent Design: The Scientific Alternative to Evolution" in the National Catholic Bioethics Quarterly. Calvert also has written a play about intelligent design in a high school biology class with Daniel Schwabauer.

- The Foundation for Thought and Ethics (FTE) is a Christian non-profit organization based in Richardson, Texas that publishes textbooks and articles promoting intelligent design, abstinence, and Christian nationism. In addition, the foundation's officers and editors are some of the leading proponents of intelligent design. The FTE has close associations with the Discovery Institute, hub of the intelligent design movement and other religious Christian groups.

Activism

The intelligent design movement primarily campaigns on two fronts: a public relations campaign meant to influence the popular media and sway public opinion; and an aggressive lobbying campaign to cultivate support for the teaching of intelligent design amongst policymakers and the wider educational community. Both these activities are largely funded and directed by the Discovery Institute, from national to grassroots levels. The movement's first goal is to establish an acceptance of intelligent design at the expense of evolution in public school science; its long-term goal is no less than the "renewal" of American culture through the shaping of public policy to reflect conservative Christian values. As the Discovery Institute states, intelligent design is central to this agenda: "Design theory promises to reverse the stifling dominance of the materialist worldview, and to replace it with a science consonant with Christian and theistic convictions."

The Discovery Institute has also relied on several polls to indicate the acceptance of intelligent design. A 2005 Harris poll identified ten percent of adults in the United States as taking what they called the intelligent design position, that "human beings are so complex that they required a powerful force or intelligent being to help create them". (64% agreed with the creationist view that "human beings were created directly by God" and 22% believed that "human beings evolved from earlier species". However, 49% accepted plant and animal evolution, while 45% did not.) Although some polls commissioned by the Discovery Institute show more support, these polls have been criticized as suffering from considerable flaws, such as having a low response rate (248 out of 16,000), being conducted on behalf of an organization with an expressed interest in the outcome of the poll, and containing leading questions.

Critics of intelligent design and its movement contend that intelligent design is a specific form of creationism, neo-creationism, a viewpoint rejected by intelligent design advocates. It was bolstered by the 2005 ruling in United States federal court that a public school district requirement for science classes to teach that intelligent design is an alternative to evolution was a violation of the Establishment Clause of the First Amendment to the United States Constitution. In *Kitzmiller v. Dover Area School District* (2005), United States District Judge John E. Jones III also ruled that intelligent design is not science and is essentially religious in nature.

In pursuing the goal of establishing intelligent design at the expense of evolution in public school science, intelligent design groups have threatened and isolated high school science teachers, school board members and parents who opposed their efforts. Responding to the well-organized curricular challenges of intelligent design proponents to local school boards have been disruptive and divisive in the communities where they've taken place. The campaigns run by intelligent design groups place teachers in the difficult position of arguing against their employers while the legal challenges to local school districts are costly and divert scarce funds away from education into court battles. Although these court battles have almost invariably resulted in the defeat of intelligent design proponents, they are draining and divisive to local schools. For example, as a result of Kitzmiller v. Dover Area School District trial, the Dover Area School District was forced to pay $1,000,011 in legal fees and damages for pursuing a policy of *teaching the controversy* - presenting intelligent design as an allegedly scientific alternative to evolution.

Leading members of the intelligent design movement are also associated with denialism, both Phillip Johnson and Jonathan Wells have signed an AIDS denialism petition.

Campaigns

The Discovery Institute, through its Center for Science and Culture, has formulated a number of campaigns to promote intelligent design, while discrediting evolutionary biology, which the Institute terms "Darwinism."

Prominent Institute campaigns have been to 'Teach the Controversy' and, more recently, to allow Critical Analysis of Evolution. Other prominent campaigns have claimed that intelligent design advocates (most notably Richard Sternberg) have been discriminated against, and thus that Academic Freedom bills are needed to protect academics' and teachers' ability to criticise evolution, and that there is a link from evolution to ideologies such as Nazism and eugenics. These three claims are all publicised in the pro-ID movie *Expelled: No Intelligence Allowed*. Other campaigns have included petitions, most notably A Scientific Dissent From Darwinism.

The response of the scientific community has been to reiterate that the theory of evolution is overwhelmingly accepted as a matter of scientific consensus whereas intelligent design has been rejected by the overwhelming majority of the scientific community.

Politics and public education

The main battlefield for this culture war has been U.S. regional and state school boards. Courts have also become involved as those campaigns to include intelligent design or weaken the teaching of evolution in public school science curricula are challenged on First Amendment grounds. In Kitzmiller v. Dover Area School District the plaintiffs successfully argued that intelligent design is a form of creationism, and that the school board policy thus violated the Establishment Clause of the First Amendment.

Intelligent design is an integral part of a political campaign by cultural conservatives, largely from evangelical religious convictions, that seek to redefine science to suit their own ideological agenda. Though numerically a minority of Americans,. the politics of intelligent design is based less on numbers than on intensive mobilization of ideologically committed followers and savvy public relations campaigns. Political repercussions from the culturally conservative sponsorship of the issue has been divisive and costly to the effected communities, polarizing and dividing not only those directly charged with educating young people but entire local communities.

With a doctrine that calls itself science among non-scientists but is rejected by the vast majority of the real practitioners, an amicable coexistence and collaboration between intelligent design advocates and upholders of mainstream science education standards is rare. With mainstream scientific and educational organizations saying the theory of evolution is not "in crisis" or a subject doubted by scientists, nor intelligent design the emergent scientific paradigm or rival theory its proponents proclaim, "teaching the controversy" is suitable for classes on politics, history, culture, or theology they say, but not science. By attempting to force the issue into science classrooms, intelligent design proponents create a charged environment that forces participants and bystanders alike to declare their positions, which has resulted in intelligent design groups threatening and isolating high school science teachers, school board members and parents who opposed their efforts.

In a round table discussion entitled "Science Wars: Should Schools Teach Intelligent Design?" at the American Enterprise Institute on 21 October 2005 and televised on C-SPAN, the Discovery Institute's Mark Ryland and the Thomas More Law Center's Richard Thompson had a frank disagreement, in which Ryland claimed the Discovery Institute has always cautioned against the teaching of intelligent design, and Thompson responded that the institute's leadership had not only advocated the teaching of intelligent design, but encouraged others to do so, and that the Dover Area School District had merely followed the institute's calls for action. As evidence, Thompson cited the Discovery Institute's guidebook *Intelligent Design in Public School Science Curricula* written by the institute's director and co-founder, Stephen C. Meyer and David DeWolf, a fellow of the institute, which stated in its closing paragraphs: "*Moreover, as the previous discussion demonstrates, school boards have the authority to permit, and even encourage, teaching about design theory as an alternative to Darwinian evolution -- and this includes the use of textbooks such as Of Pandas and People that present evidence for the theory of intelligent design.*"

Higher education

The battle to bring intelligent design and its social and political agenda the high school science classroom is well established. Bringing intelligent design to higher education is also an active part of Discovery Institute's strategy, though it has not taken the normal path of emergent scientific paradigms, through graduate schools and leading professional journals of science. It has been out of the question for intelligent design to be successfully introduced to the public via higher education venues and gain standing in such scientific

courts as long as the evidence for evolution continues to grow in the view of the scientific community. The Discovery Institute acknowledges that if intelligent design is to become part of college and university science curricula, it will come to campus via students, their parents, sympathetic faculty, and the impositions of consumer-conscious college administrators. To that end the institute has supported 'IDEA' intelligent design student groups at various campuses, and reports having faculty supporters on every university campus in this country including the Ivy League schools. Academics who are Discovery Institute fellows include Robert Kaita of Princeton University, Henry F. Schaefer of the University of Georgia, Robert Koons and J. Budziszewski of the University of Texas at Austin, and Guillermo Gonzalez of Iowa State University. Prominent academics who, although not officially associated with the Discovery Institute, sympathize with its aims, include Alvin Plantinga at Notre Dame, Christopher Macosko at University of Minnesota, Jed Macosko at Wake Forest University, and Frank Tipler at Tulane University.

A number of religious schools offer Discovery Institute-recommended curricula. Biola University and Oklahoma Baptist University are listed on the Access Research Network website as "ID Colleges." The intelligent design and Undergraduate Research Center, ARN's student division, also recruits and supports followers at universities. Campus youth ministries play an active role in bringing intelligent design to university campuses through lectures by intelligent design leaders Phillip Johnson, William Dembski, Jonathan Wells, Michael Behe and others. This activity takes place outside university science departments.

The few university presses (such as Cambridge and Michigan State) that have published intelligent design books classify them as philosophy, rhetoric, or public affairs, not science. There are no peer-reviewed studies supporting intelligent design in the scientific research literature. With the scientific community as a whole unmoved or unconvinced by proponents' works and rhetoric and the absence of intelligent design scientific research programs, Dembski conceded that "the scientific research part" of intelligent design is now "lagging behind" its success in influencing popular opinion.

In 2005 the American Association of University Professors issued a strongly worded statement asserting that the theory of evolution is nearly universally accepted in the community of scholars, and criticizing the intelligent design movement's attempts to weaken or undermine the teaching of evolution as "inimical to principles of academic freedom."

The Discovery Institute organizes on-campus intelligent design conferences across the US for students. In the beginning, these were generally held at Christian universities and often sponsored by the administration or other faculty as an official university function. Lateron, Yale and the University of San Francisco have seen proponents of intelligent design speak on their campuses. Not only did these succeed in reaching out to a more secular group of students, but the backdrop of prestigious universities achieved a goal set forth in the Wedge strategy; to lend an aura of academic legitimacy to the proceedings and by extension, the intelligent design movement. Commenting on the Yale conference,

for example, a student auxiliary of the Access Research Network stated, "Basically, the conference, beside being a statement (after all we were meeting at Yale University), proved to be very promising." These conferences were not sponsored by the universities at which they were held. They were sponsored by associated religious organizations — at Yale, the Rivendell Institute for Christian Thought and Learning.

The Web

Much of the actual debate over intelligent design between intelligent design proponents and members of the scientific community has taken place on the Web, primarily blogs and message boards, instead of the scientific journals and symposia where traditionally much science is discussed and settled. In promoting intelligent design the actions of its proponents have been more like a political pressure group than like researchers entering an academic debate as described by movement critic Taner Edis. In the absence of any verifiable scientific research program and concomitant debates in academic circles, the most vibrant venues for intelligent design debate are websites such as Pandas Thumb , Dembski's blogs at UncommonDescent.com and DesignInference.com and the Discovery Institute's Evolutionnews.org , often with discussions and their various responses taking place on two or more sites at a time.

International

Despite being primarily based in the United States, there have been efforts to introduce pro Intelligent Design teaching material into educational facilities in other countries. In the United Kingdom, the group Truth in Science has used material from the Discovery Institute to create free teaching packs which have been mass-mailed to all UK schools. Shortly after this emerged, government ministers announced that they regarded intelligent design to be creationism and unsuitable for teaching in the classroom. They also announced that the teaching of the material in science classes was to be prohibited.

Criticisms of the movement

One of the most common criticisms of the movement and its leadership is that of intellectual dishonesty, in the form of misleading impressions created by the use of rhetoric, intentional ambiguity, and misrepresented evidence. It is alleged that its goal is to lead an unwary public to reach certain conclusions, and that many have been deceived as a result. Critics of the movement, such as Eugenie Scott, Robert Pennock and Barbara Forrest, claim that leaders of the Intelligent Design movement, and the Discovery Institute in particular, knowingly misquote scientists and other experts, deceptively omit contextual text through ellipsis, and make unsupported amplifications of relationships and credentials. Theologian and molecular biophysicist Alister McGrath has a number of criticisms of the Intelligent design movement, stating that "those who adopt this approach make Christianity deeply... vulnerable to scientific progress" and defining it as just another "god-of-the-gaps" theory. He went on to criticize the movement on theological grounds as well, stating "It is not an approach I accept, either on scientific or theological grounds."

Critics claim that the institute uses academic credentials and affiliations opportunistically. In 2001, the Discovery Institute purchased advertisements in three national publications (the *New York Review of Books*, the *New Republic* and the *Weekly Standard*) to proclaim the adherence of approximately 100 scientists to the following statement: "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."

Such statements commonly note the institutional affiliations of signatories for purposes of identification. But this statement strategically listed either the institution that granted a signatory's PhD or the institutions with which the individual is presently affiliated. Thus the institutions listed for Raymond G. Bohlin, Fazale Rana, and Jonathan Wells, for example, were the University of Texas, Ohio University, and the University of California, Berkeley, where they earned their degrees, rather than their current affiliations: *Probe Ministries* for Bohlin, *The Reasons to Believe Ministry* for Rana, and *The Discovery Institute's Center for Science and Culture* for Wells. Similarly confusing lists of local scientists were circulated during controversies over evolution education in Georgia, New Mexico, Ohio, and Texas. In another instance, the Discovery Institute frequently mentions the Nobel Prize in connection with Henry F. Schaefer, a Discovery Institute fellow, and chemist at the University of Georgia. Critics allege that Discovery Institute is inflating his reputation by constantly referring to him as a "five-time nominee for the Nobel Prize" because Nobel Prize nominations remain confidential for fifty years.

This criticism is not reserved only to the institute; individual intelligent design proponents have been accused of using their own credentials and those of others in a misleading or confusing fashion. For example, critics allege William Dembski gratuitously invokes his laurels by boasting of his correspondence with a Nobel laureate, bragging that one of his books was published in a series whose editors include a Nobel laureate, and exulting that the publisher of the intelligent design book *The Mystery of Life's Origin*, Philosophical Library Inc., also published books by eight Nobel laureates. Critics claim that Dembski purposefully omits relevant facts which he fails to mention to his audience that in 1986, during the Edwards v. Aguillard hearings, 72 Nobel laureates endorsed an amicus curiae brief that noted that the "evolutionary history of organisms has been as extensively tested and as thoroughly corroborated as any biological concept."

Another common criticism is that since no intelligent design research has been published in mainstream, peer-reviewed scientific journals, the Discovery Institute often misuses the work of mainstream scientists by putting out lists of articles that allegedly support their arguments for intelligent design drawing from mainstream scientific literature. Often, the original authors respond that their articles cited by the center don't support their arguments at all. Many times, the original authors have publicly refuted them for distorting the meaning of something they've written for their own purposes.

Sahotra Sarkar, a molecular biologist at the University of Texas, has testified that intelligent design advocates, and specifically the Discovery Institute, have misused his

work by misrepresenting its conclusions to bolster their own claims, has gone on to allege that the extent of the misrepresentations rises to the level of professional malfeasance:

"When testifying before the Texas State Board of Education in 2003 (in a battle over textbook adoption that we won hands down), I claimed that my work had been maliciously misused by members of the Discovery Institute. ... The trouble is that it says nothing of the sort that Meyer claims. I don't mention Dembski, ID, or "intelligent" information whatever that may be. I don't talk about assembly instructions. In fact what the paper essentially does is question the value of informational notions altogether, which made many molecular biologists unhappy, but which is also diametrically opposed to the "complex specified information" project of the ID creationists. ... Notice how my work is being presented as being in concordance with ID when Meyer knows very well where I stand on this issue. If Meyer were an academic, this kind of malfeasance would rightly earn him professional censure. Unfortunately he's not. He's only the Director of the Discovery Institute's Center for Science and Culture." -- *Sahotra Sarkar*

An October 2005 conference called "When Christians and Cultures Clash" was held at the Pennsylvania Evangelical School of Theology. Attorney Randy Wenger, who is affiliated with the Alliance Defense Fund, and a close ally of the Discovery Institute, and one of the presenters at the conference advocated the use of subterfuge for advancing the movement's religious goals: "But even with God’s blessing, it’s helpful to consult a lawyer before joining the battle. For instance, the Dover area school board might have had a better case for the intelligent design disclaimer they inserted into high school biology classes had they not mentioned a religious motivation at their meetings. Give us a call before you do something controversial like that, I think we need to do a better job at being clever as serpents."

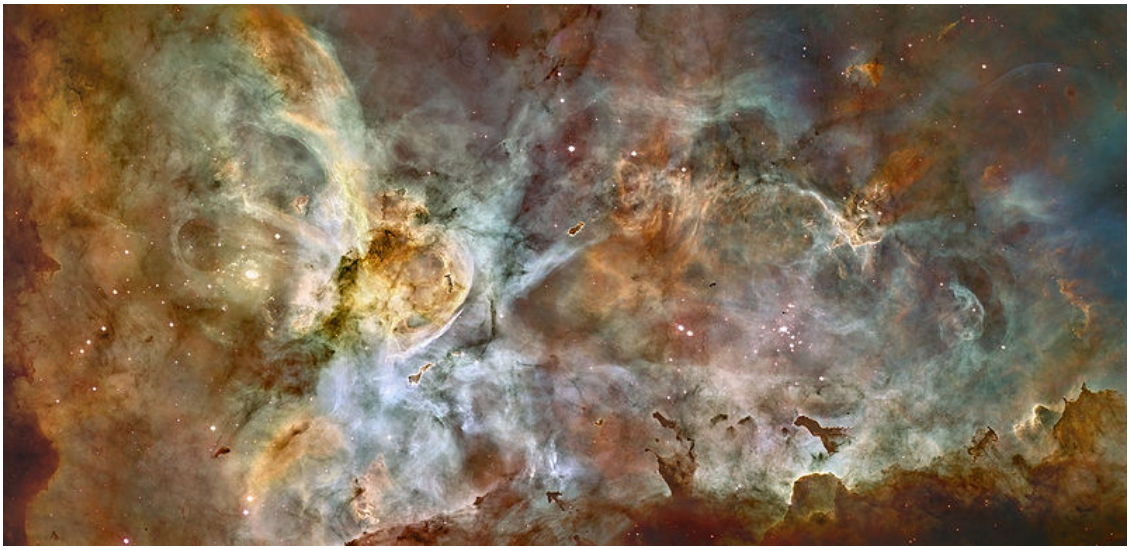
Chapter- 6

Fine-tuned Universe

The **fine-tuned Universe** is the idea that the conditions that allow life in the Universe can only occur when certain universal fundamental physical constants lie within a very narrow range, so that if any of several fundamental constants were only slightly different the universe would be unlikely to be conducive to the establishment and development of matter, astronomical structures, elemental diversity, or life as it is presently understood.

The existence and extent of fine-tuning in the universe is a matter of dispute in the scientific community. Proponents of fine-tuning include physicist Paul Davies who has stated "There is now broad agreement among physicists and cosmologists that the universe is in several respects ‘fine-tuned' for life". Other physicists such as Victor Stenger dispute fine-tuning, saying that even though "life as we know it would not exist if any one of several of the constants of physics were just slightly different, [we] cannot prove that some other form of life is feasible with a different set of constants. Anyone who insists that our form of life is the only one conceivable is making a claim based on no evidence and no theory." Among scientists who find the evidence persuasive, a variety of scientific explanations have been proposed, e.g., the anthropic principle along with multiple universes. The idea has also attracted discussion among philosophers and theologians, as well as creationists and proponents of the Intelligent Design movement.

Premise



Fine-tuned Universe proponents argue that deep-space structures such as the Eta Carinae Nebula would not form in a universe with significantly different physical constants.

The premise of the fine-tuned universe assertion is that a small change in several of the dimensionless fundamental physical constants would make the universe radically different. As Stephen Hawking has noted, "The laws of science, as we know them at present, contain many fundamental numbers, like the size of the electric charge of the electron and the ratio of the masses of the proton and the electron. ... The remarkable fact is that the values of these numbers seem to have been very finely adjusted to make possible the development of life."

If, for example, the strong nuclear force were 2% stronger than it is (i.e., if the coupling constant representing its strength were 2% larger), while the other constants were left unchanged, diprotons would be stable and hydrogen would fuse into them instead of deuterium and helium. This would drastically alter the physics of stars, and presumably preclude the existence of life similar to what we observe on Earth. However, many of the fundamental constants describe the properties of the unstable strange, charmed, bottom and top quarks and mu and tau leptons which seem to play little part in the universe or the structure of matter.

The precise formulation of the idea is made difficult by the fact that physicists do not yet know how many independent physical constants there are. The current standard model of particle physics has 25 freely adjustable parameters (there is an additional parameter for gravitation, the cosmological constant). However, because the standard model is not mathematically self-consistent under certain conditions (e.g., at very high energies, at which both quantum mechanics and general relativity are relevant), physicists believe that it is underlaid by some other theory, such as a grand unified theory, string theory, or loop quantum gravity. In some candidate theories, the actual number of independent

physical constants may be as small as 1. For example, the cosmological constant may be a fundamental constant, but attempts have also been made to calculate it from other constants, and according to the author of one such calculation, "the small value of the cosmological constant is telling us that a remarkably precise and totally unexpected relation exists among all the parameters of the Standard Model of particle physics, the bare cosmological constant and unknown physics."

Martin Rees formulates the fine-tuning of the universe in terms of the following six dimensionless constants:

- N = ratio of the strength of electromagnetism to that of gravity;
- *Epsilon* (ε) = strength of the force binding nucleons into nuclei;
- *Omega* (ω) = relative importance of gravity and expansion energy in the universe;
- *Lambda* (λ) = cosmological constant;
- Q = ratio of the gravitational energy required to pull a large galaxy apart to the energy equivalent of its mass;
- D = number of spatial dimensions in spacetime.

Disputes on the extent and existence of fine-tuning

Computer simulations suggest that not all of the purportedly "fine-tuned" parameters may be as fine-tuned as has been claimed. Victor Stenger has simulated different universes in which four fundamental parameters are varied. He found that long-lived stars could exist over a wide parameter range, and concluded that "... a wide variation of constants of physics leads to universes that are long-lived enough for life to evolve, although human life need not exist in such universes". However Stenger's work has been criticised as having several fundamental flaws by other physicists.

Fred Adams has done a similar study to Stenger, investigating the structure of stars in universes with different values of the gravitational constant G, the fine-structure constant α, and a nuclear reaction rate parameter C. His study suggests that roughly 25% of this parameter space allows stars to exist. However, Adams has been criticised for making unjustified assumptions. Harnik, Kribs and Perez have argued for the viability of a universe with no weak interaction at all. However, they noted that their analysis does not extend to the supposed fine tuning of the cosmological constant, and concluded that "the fine-tuning problems associated with the electroweak breaking scale and the cosmological constant appear to be qualitatively different from the perspective of obtaining a habitable universe."

The validity of fine tuning examples is sometimes questioned on the grounds that such reasoning is subjective anthropomorphism applied to natural physical constants. Critics also suggest that the fine-tuned universe assertion and the anthropic principle are essentially tautologies. The fine-tuned universe argument has also been criticized as an argument by lack of imagination because it assumes no other forms of life, sometimes referred to as carbon chauvinism. Conceptually, alternative biochemistry or other forms of life are possible. In addition, critics argue that humans are adapted to the universe

through the process of evolution, rather than the universe being adapted to humans. They also see it as an example of the logical flaw of hubris or anthropocentrism in its assertion that humans are the purpose of the universe.

Possible naturalistic explanations

There are fine tuning arguments that are naturalistic. As modern cosmology developed, various hypotheses have been proposed. One is an oscillatory universe or a multiverse where physical constants are postulated to resolve themselves to random values in different iterations of reality. Under this hypothesis, separate parts of reality would have wildly different characteristics. In such scenarios the issue of fine-tuning does not arise at all, as only those "universes" with constants hospitable to life (such as what we observe) would develop life capable of asking the question.

Based upon the Anthropic principle, physicist Robert H. Dicke proposed the "Dicke coincidence" argument that the structure (age, physical constants, etc.) of the universe as seen by living observers is not random, but is constrained by biological factors that require it to be roughly a "golden age".

Multiverse

The Multiverse hypothesis assumes the existence of many universes with different physical constants, some of which are hospitable to intelligent life. Because we are intelligent beings, we are by definition in a hospitable one. Mathematician Michael Ikeda and astronomer William H. Jefferys have argued that the anthropic principle resolves the entire issue of fine-tuning, as does philosopher of science Elliott Sober. Philosopher and theologian Richard Swinburne reaches the opposite conclusion using Bayesian probability.

This approach has led to considerable research into the anthropic principle and has been of particular interest to particle physicists because theories of everything do apparently generate large numbers of universes in which the physical constants vary widely. As of yet, there is no evidence for the existence of a multiverse, but some versions of the theory do make predictions which some researchers studying M-theory and gravity leaks hope to see some evidence of soon. The existence of additional universes in a multiverse, other than the observable universe, is not falsifiable, and thus some are reluctant to call the multiverse idea a "scientific" idea. UNC-Chapel Hill professor Laura Mersini-Houghton claims that the WMAP cold spot may provide testable empirical evidence for a parallel universe.

Variants on this approach include Lee Smolin's notion of cosmological natural selection, the Ekpyrotic universe, and the Bubble universe theory.

Critics of the multiverse-related explanations argue that there is no evidence that other universes exist.

Bubble universe theory

The bubble universe model by physicist Andrei Linde, postulates that our universe is one of many that grew from a multiverse consisting of vacuum that had not yet decayed to its ground state.

According to this scenario, by means of a random quantum fluctuation the universe "tunneled" from pure vacuum ("nothing") to what is called a false vacuum, a region of space that contains no matter or radiation but is not quite "nothing." The space inside this bubble of false vacuum was curved, or warped. A small amount of energy was contained in that curvature, somewhat like the energy stored in a strung bow. This ostensible violation of energy conservation is allowed by the Heisenberg uncertainty principle for sufficiently small time intervals.

The bubble then inflated exponentially and the universe grew by many orders of magnitude in a tiny fraction of a second. As the bubble expanded, its curvature energy was converted into matter and radiation, inflation stopped, and the more linear big bang expansion we now experience commenced. The universe cooled and its structure spontaneously froze out, as formless water vapor freezes into snowflakes whose unique patterns arise from a combination of symmetry and randomness.

—Victor J. Stenger, *The Anthropic Coincidences*

In standard inflation, inflationary expansion occurred while the universe was in a false vacuum state, halting when the universe decayed to a true vacuum state. The *bubble universe* model proposes that different parts of this inflationary universe (termed a Multiverse) decayed at different times, with decaying regions corresponding to universes not in causal contact with each other. It further supposes that each bubble universe may have different physical constants.

Top-down cosmology

Stephen Hawking, along with Thomas Hertog of CERN, proposed that the universe's initial conditions consisted of a superposition of many possible initial conditions, only a small fraction of which contributed to the conditions we see today. According to their theory, it is inevitable that we find our universe's "fine-tuned" physical constants, as the current universe "selects" only those past histories that led to the present conditions. In this way, top-down cosmology provides an anthropic explanation for why we find ourselves in a universe that allows matter and life, without invoking the current existence of a multiverse.

Alien design

One hypothesis is that the Universe may have been designed by extra-universal aliens. Some believe this would solve the problem of how a designer or design team capable of fine-tuning the Universe could come to exist. Cosmologist Alan Guth believes humans

will in time be able to generate new universes. By implication previous intelligent entities may have generated our universe. This idea leads to the possibility that the extraterrestrial designer/designers are themselves the product of an evolutionary process in their own universe, which must therefore itself be able to sustain life. For instance, Richard Dawkins maintains that an alien designer or designers are more plausible than a supernatural designer or designers because there is a known mechanism to produce them. He calls it the “crane” of Natural selection. Dawkins' claims, though, are criticized among philosophers (e.g. Richard Swinburne, Alvin Plantinga, Nancey Murphy) to just push back the problem further (now it would be no more the case to explain this universe, but the universe in which those aliens live), and it could be argued that the resulting universe where the aliens live calls even more for a designer that would be eternal and uncreated (that is God). Further, in Richard Dawkins' ultimate Boeing 747 gambit he explains that evolution is an even more plausible "crane".

The Simulation hypothesis promoted by Nick Bostrom and others suggests that our universe may be a computer simulation by aliens.

The Biocosm hypothesis and the Meduso-anthropic principle both suggest that natural selection has made the universe biophilic. The universe enables intelligence because intelligent entities later create new biophilic universes. This is different from the suggestion above that aliens from a universe which is less finely tuned than ours made our universe finely tuned.

Religious opinions

As with theistic evolution, some individual scientists, theologians, and philosophers as well as certain religious groups argue that providence or creation are responsible for fine-tuning.

Christian philosopher Alvin Plantinga argues that random chance, applied to a single and sole universe, only begs the question as to why this universe could be so "lucky" as to have precise conditions that support life at least at some place (the Earth) and time (within millions of years of the present).

One reaction to these apparent enormous coincidences is to see them as substantiating the theistic claim that the universe has been created by a personal God and as offering the material for a properly restrained theistic argument—hence the fine-tuning argument. It's as if there are a large number of dials that have to be tuned to within extremely narrow limits for life to be possible in our universe. It is extremely unlikely that this should happen by chance, but much more likely that this should happen if there is such a person as God.

This apparent fine-tuning of the universe is cited by theologian William Lane Craig as an evidence for the existence of God or some form of intelligence capable of manipulating (or designing) the basic physics that governs the universe. Craig argues, however, "that the postulate of a divine Designer does not settle for us the religious question."

Variants on this approach include:

Intelligent design

Proponents of Intelligent design argue that certain features of the universe and of living things are best explained by an intelligent cause, not an undirected process such as natural selection. The fine-tuned universe argument is a central premise or presented as a given in many of the published works of prominent Intelligent Design proponents, such as William A. Dembski and Michael Behe.

Other religious creation views

Most religions have some kind of account of the creation of the universe, although they generally differ in detail from the ones listed above. Some of these may be compatible with known scientific facts. For example scientist-theologians such as John Polkinghorne emphasize the implications of *Anthropic Fine-Tuning* within an orthodox Christian framework whilst fully accepting the scientific findings about Evolution and the age of the Universe. This is also the position of the Roman Catholic Church and of most Anglican theologians. The Jewish physicist Gerald Schroeder argues that the apparent discrepancy between the "days" in Genesis and the billions of years in a scientific understanding are due to the differences in frames of reference. Many other religious creation views are either incompatible with, or indifferent to, scientific understandings. Other scientists with similar views are physicist Freeman Dyson and astronomer Owen Gingerich.

Counter argument to religious views

Victor Stenger argues that "... The fine-tuning argument and other recent intelligent design arguments are modern versions of God of the gaps reasoning, where a God is deemed necessary whenever science has not fully explained some phenomenon".

The argument from imperfection suggests that if the universe were designed to be fine-tuned for life, it should be the best one possible and that evidence suggests that it is not. In fact, most of the universe is highly hostile to life.

Additionally Stenger argues, "We have no reason to believe that our kind of carbon-based life is all that is possible. Furthermore, modern cosmology indicates that multiple universes may exist with different constants and laws of physics. So, it is not surprising that we live in the one suited for us. The universe is not fine-tuned to life; life is fine-tuned to the universe."

In fiction and popular culture

- Robert J. Sawyer discusses the fine-tuned universe at length in his novel *Calculating God* (2000).

- Author Neal Stephenson discussed the issue of fine-tuning in the conclusion to his essay In the Beginning... was the Command Line.
- **Puddle thinking** is a satirical illustration of the *"life is fine-tuned to the universe"* argument above coined by Douglas Adams to satirize the Fine-tuned Universe argument for supernatural creationism. As quoted in Richard Dawkins' eulogy for Douglas Adams:

... imagine a puddle waking up one morning and thinking, 'This is an interesting world I find myself in, an interesting hole I find myself in, fits me rather neatly, doesn't it? In fact it fits me staggeringly well, must have been made to have me in it!' This is such a powerful idea that as the sun rises in the sky and the air heats up and as, gradually, the puddle gets smaller and smaller, it's still frantically hanging on to the notion that everything's going to be all right, because this world was meant to have him in it, was built to have him in it; so the moment he disappears catches him rather by surprise. I think this may be something we need to be on the watch out for.