

Debating Design
From Darwin to DNA

Edited by

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Notes on Contributors

Francisco J. Ayala was born in Madrid, Spain, and has been a U.S. citizen since 1971. Ayala has been president and chairman of the board of the American Association for the Advancement of Science (1993–96) and was a member of the President’s Committee of Advisors on Science and Technology (1994–2001). Ayala is currently Donald Bren Professor of Biological Sciences and of Philosophy at the University of California at Irvine. He is a recipient of the National Medal of Science for 2001. Other honors include election to the National Academy of Sciences, the American Academy of Arts and Sciences, the American Philosophical Society, and numerous foreign academies, including the Russian Academy of Sciences and the Accademia Nazionale dei Lincei (Rome). He has received numerous prizes and honorary degrees. His scientific research focuses on population and evolutionary genetics, including the origin of species, genetic diversity of populations, the origin of malaria, the population structure of parasitic protozoa, and the molecular clock of evolution. He also writes about the interface between religion and science and on philosophical issues concerning epistemology, ethics, and the philosophy of biology. He is author of more than 750 articles and of 18 books.

James Barham was trained in classics at the University of Texas at Austin and in the history of science at Harvard University. He is an independent scholar who has published some dozen articles on evolutionary epistemology, the philosophy of mind, and the philosophy of biology in both print and electronic journals, including *BioSystems*, *Evolution and Cognition*, *Rivista di Biologia*, and *Metanexus.net*. His work consists of a critique of the mechanistic and Darwinian images of life and mind, as well as an exploration of alternative means of understanding value, purpose, and meaning as objectively real, natural phenomena, in both their human and their universal biological manifestations. He is working on a book to be called *Neither Ghost nor Machine*.

Michael J. Behe graduated from Drexel University in Philadelphia in 1974, with a B.S. degree in chemistry. He did graduate studies in biochemistry at the University of Pennsylvania and was awarded a Ph.D. in 1978 for his dissertation research on sickle-cell disease. From 1978 to 1982, he did post-doctoral work on DNA structure at the National Institutes of Health. From 1982 to 1985, he was an assistant professor of chemistry at Queens College in New York City. In 1985 he moved to Lehigh University, where he is currently a professor of biochemistry. In his career he has authored more than forty technical papers and one book, *Darwin's Black Box: The Biochemical Challenge to Evolution*, which argues that living systems at the molecular level are best explained as being the result of deliberate intelligent design. *Darwin's Black Box* has been reviewed by the *New York Times*, *Nature*, *Philosophy of Science*, *Christianity Today*, and more than eighty other publications and has been translated into eight languages. He and his wife reside near Bethlehem, Pennsylvania, with their eight children.

Walter L. Bradley, Ph.D., P.E., received his B.S. in engineering science and his Ph.D. in materials science, both from the University of Texas at Austin. He taught for eight years as an assistant and associate professor at the Colorado School of Mines in its Metallurgical Engineering Department before assuming a position as professor of mechanical engineering at Texas A&M University in 1976. He served as head of his department of 67 professors and 1,500 students from 1989 to 1993. He also served as the director of the Texas A&M University Polymer Technology Center from 1986 to 1990 and from 1994 to 2000. He has received more than \$5 million in research contracts from government agencies such as NSF, NASA, DOE, and AFOSR and from major corporations such as Dupont, Exxon, Shell, Phillips, Equistar, Texas Eastman, Union Carbide, and 3M. He has published more than 125 technical articles in archival journals, conference proceedings, and as book chapters. He was honored by being elected a Fellow of the American Society for Materials in 1992. He has received one national and five local research awards and two local teaching awards. He coauthored a seminal work on the origin of life entitled *The Mystery of Life's Origin: Reassessing Current Theories* in 1984, has published several book chapters and journal articles related to the origin of life, and has spoken on more than sixty university campuses on this topic over the past ten years. He took early retirement from Texas A&M University in 2000 and now holds the title of Professor Emeritus of Mechanical Engineering.

Paul Davies was born in London in 1946 and obtained a doctorate from University College, London, in 1970. He held academic appointments at Cambridge and London Universities until, at the age of thirty-four, he was appointed professor of theoretical physics at the University of Newcastle upon Tyne. From 1990 until 1996 he was professor of mathematical physics,

and later of natural philosophy, at the University of Adelaide. He currently holds the positions of visiting professor at Imperial College, London, and honorary professor at the University of Queensland, although he remains based in south Australia, where he runs a science, media, and publishing consultancy called Orion Productions. Professor Davies has published more than 100 research papers in specialist journals in the areas of cosmology, gravitation, and quantum field theory, with particular emphasis on black holes and the origin of the universe. In addition to his research, Professor Davies is well known as an author, broadcaster, and public lecturer. He has written more than twenty-five books, including *God and the New Physics*, *The Cosmic Blueprint*, *The Mind of God*, *The Last Three Minutes*, *About Time*, *Are We Alone?* and *The Fifth Miracle*. Davies's commitment to bringing science to the wider public includes a heavy program of public lecturing in Australia, Europe, and the United States. In addition to addressing scientific topics, Davies lectures to religious organizations around the world and has had meetings with the Pope and the Dalai Lama. He frequently debates science and religion with theologians. Paul Davies is married and has four children.

William A. Dembski is an associate research professor in the conceptual foundations of science at Baylor University and a senior Fellow with Discovery Institute's Center for Science and Culture in Seattle. He is also the executive director of the International Society for Complexity, Information, and Design <www.iscid.org>, a professional society that explores complex systems apart from programmatic constraints such as naturalism. Dr. Dembski previously taught at Northwestern University, the University of Notre Dame, and the University of Dallas. He has done postdoctoral work in mathematics at MIT, in physics at the University of Chicago, and in computer science at Princeton University. A graduate of the University of Illinois at Chicago, where he earned a B.A. in psychology, an M.S. in statistics, and a Ph.D. in philosophy, he also received a doctorate in mathematics from the University of Chicago in 1988 and a master of divinity degree from Princeton Theological Seminary in 1996. He has held National Science Foundation graduate and postdoctoral fellowships. Dr. Dembski has published articles in mathematics, philosophy, and theology journals and is the author of several books. In *The Design Inference: Eliminating Chance through Small Probabilities* (Cambridge University Press, 1998), he examines the design argument in a post-Darwinian context and analyzes the connections linking chance, probability, and intelligent causation.

David J. Depew is professor of communication studies and rhetoric of inquiry at the University of Iowa. He is the coauthor, with Bruce H. Weber, of *Darwinism Evolving: Systems Dynamics and the Genealogy of Natural Selection* (1994). He is currently at work, with Marjorie Grene, on a history of the philosophy of biology to be published by Cambridge University Press.

John F. Haught is the Landegger Distinguished Professor of Theology at Georgetown University. Dr. Haught received his Ph.D. from Catholic University of America. He served as chair of the Georgetown Department of Theology from 1990 to 1995. He is now also director of the Georgetown Center for the Study of Science and Religion. Dr. Haught has published many articles and lectured widely, especially on topics related to religion and science, cosmology and theology, and ecology and theology. He is the author of many books, including *Responses to 101 Questions on God and Evolution* (2001), *God After Darwin* (2000), *Science and Religion: From Conflict to Conversation* (1995), *The Promise of Nature: Ecology and Cosmic Purpose* (1993), *Mystery and Promise: A Theology of Revelation* (1993), *What Is Religion?* (1990), *The Revelation of God in History* (1988), *What Is God?* (1986), *The Cosmic Adventure* (1984), *Nature and Purpose* (1980), and *Religion and Self-Acceptance* (1976), and he is the editor of *Science and Religion in Search of Cosmic Purpose* (2000).

Stuart Kauffman is an external professor for the Santa Fe Institute in New Mexico. He received his M.D. degree from the University of California at San Francisco in 1968 and was a professor in biochemistry and biophysics at the University of Pennsylvania until 1995. Since 1985, he has been a consultant for Los Alamos National Laboratory, and from 1986 to 1997 he was a professor at the Santa Fe Institute. Dr. Kauffman is also a founding general partner of the Bios Group in Santa Fe. He has served on the editorial boards of numerous scientific journals, including the *Journal of Theoretical Biology*. He is the author or coauthor of more than 100 scientific articles and the author of three books: *Origins of Order: Self-Organization and Selection in Evolution* (1993), *At Home in the Universe* (1995), and *Investigations* (2000).

Angus Menuge is associate professor of philosophy and program associate of the Cranach Institute at Concordia University, Wisconsin <www.cuw.edu/institutes/Cranach/>. He received his B.A. in philosophy from the University of Warwick and his Ph.D., on action explanation, from the University of Wisconsin–Madison. Dr. Menuge is editor of three books – *C. S. Lewis: Light-bearer in the Shadowlands* (1997), *Christ and Culture in Dialogue* (1999), and *Reading God's World: The Vocation of Scientist* (forthcoming). With the help of William Dembski, Menuge hosted the Design and Its Critics conference in June 2000, which inspired the present volume. Dr. Menuge has written a number of recent articles on Intelligent Design and is currently writing a book defending a robust notion of agency against reductionist theories, entitled *Agents Under Fire: Materialism and the Rationality of Science*.

Stephen C. Meyer is director of the Discovery Institute's Center for Science and Culture in Seattle, Washington, and serves as University Professor, Conceptual Foundations of Science, at Palm Beach Atlantic University in West Palm Beach, Florida. He received his Ph.D. in the history and

philosophy of science from Cambridge University, where he did a dissertation on the history of origin-of-life biology and the methodology of the historical sciences. Meyer worked previously as a geophysicist for the Atlantic Richfield Company and as a professor of philosophy at Whitworth College. He is coauthor of the book *Science and Evidence of Design in the Universe* (Ignatius 2002) and coeditor of the book *Darwinism, Design and Public Education* (Michigan State University Press 2003). Meyer has contributed scientific and philosophical articles to numerous scholarly books and journals and has published opinion-editorial columns for major newspapers and magazines such as *The Wall Street Journal*, *The Los Angeles Times*, *The Chicago Tribune*, *National Review*, and *First Things*. He has appeared on national television and radio programs such as Fox News, PBS's *TechnoPolitics* and *Freedom Speaks*, MSNBC's *Hardball with Chris Matthews*, and NPR's *Talk of the Nation* and *Science Friday*. He coauthored the film *Unlocking the Mystery of Life*, which recently aired on PBS stations around the country.

Kenneth R. Miller is professor of biology at Brown University. Dr. Miller has a Sc.B. in biology from Brown University (1970) and a Ph.D. in biology from the University of Colorado (1974). He has taught at the University of Colorado, Harvard University, and Brown University, where he has been full professor since 1986. He is the recipient of numerous honors for teaching excellence. Dr. Miller is a member of the American Association for the Advancement of Science and the American Society for Cell Biology, and he has been chairman and council member of the ASCB, editor of *The Journal of Cell Science*, and general editor of *Advances in Cell Biology*. Dr. Miller's scientific interests include the structure, composition, and function of biological membranes, electron microscopy and associated techniques, and photosynthetic energy conversion. He has published a large number of technical scientific papers and essays, edited three volumes of *Advances in Cell Biology*, and is author or coauthor of several high school and college biology textbooks, including *Biology: The Living Science* and *Biology: Discovering Life*. Recently, Dr. Miller has produced a general-audience work defending evolution and its compatibility with Christian faith and critiquing Intelligent Design: *Finding Darwin's God: A Scientist's Search for Common Ground between God and Evolution* (1999).

Robert T. Pennock is associate professor of science and technology studies and philosophy at Michigan State University's Lyman Briggs School and in the Philosophy Department. He is also on the faculty of MSU's Ecology and Evolutionary Biology and Behavior program. He has published numerous articles that critique Intelligent Design creationism, including one that won a Templeton Prize for Exemplary Paper in Theology and the Natural Sciences. He is the author of *Tower of Babel: The Evidence against the New Creationism* (1999).

John Polkinghorne was professor of mathematical physics at Cambridge University, working in theoretical elementary particle physics. He was elected a Fellow of the Royal Society in 1974. In 1982 he was ordained to the priesthood in the Church of England. He is the author of a number of books about science and theology. In 1996 he retired as president of Queens' College, Cambridge, and in 1997 he was made a Knight of the British Empire.

Michael Roberts studied geology at Oxford and spent three years in Africa as an exploration geologist. He studied theology at Durham and was ordained into the Anglican Church in 1974 (along with Peter Toon). He is now vicar of Chirk, near Llangollen in North Wales. He is a keen mountain walker and has written articles on science and religion (one, on Darwin and design, received a Templeton Award in 1997) and on Darwin's British geology. In June 2000 he was a plenary speaker at the conference on Intelligent Design at Concordia University Wisconsin. He is married to Andrea, and they have two almost-grown-up children.

Michael Ruse is Lucyle T. Werkmeister Professor of Philosophy at Florida State University. He received his B.A. in philosophy and mathematics from Bristol University, an M.A. in philosophy from McMaster University, and his Ph.D. from Bristol University. He was full professor of philosophy at Guelph from 1974 to 2000. Dr. Ruse is a Fellow of the Royal Society of Canada and of the American Association for the Advancement of Science. He has received numerous visiting professorships, fellowships, and grants. Michael Ruse's many publications include *The Philosophy of Biology; Sociobiology: Sense or Nonsense?; The Darwinian Revolution: Science Red in Tooth and Claw; Darwinism Defended: A Guide to the Evolution Controversies; Taking Darwin Seriously: A Naturalistic Approach to Philosophy; But Is It Science? The Philosophical Question in the Evolution/Creation Controversy;* and *Monad to Man: The Concept of Progress in Evolutionary Biology*. His most recent works include *Mystery of Mysteries: Is Evolution a Social Construction?* and *Can a Darwinian Be a Christian? The Relationship between Science and Religion* (Cambridge University Press, 2000). Michael Ruse was the founding editor of the journal *Biology and Philosophy* and is now on the editorial board of several major journals, including *Zygon, Philosophy of Science,* and the *Quarterly Review of Biology*. On a more public level, Ruse has appeared on many television programs, including *Firing Line*, and was a witness for the ACLU in the 1981 Arkansas hearings that overturned a creation science law. His latest book is *Darwin and Design: Does Evolution have a Purpose?*

Elliott Sober is Hans Reichenbach Professor of Philosophy and Henry Vilas Research Professor at the University of Wisconsin–Madison, where he has taught since 1974. His research is in the philosophy of science, especially in the philosophy of evolutionary biology. Sober's books include *The Nature of Selection: Evolutionary Theory in Philosophical Focus* (1984, 2nd ed. 1993);

Reconstructing the Past: Parsimony, Evolution, and Inference (1988); *Philosophy of Biology* (1993); *From a Biological Point of View: Essays in Evolutionary Philosophy* (Cambridge University Press, 1994); and, most recently, *Unto Others: The Evolution and Psychology of Unselfish Behavior* (with David Sloan Wilson) (1998). Sober is a past president of the American Philosophical Association Central Division and a Fellow of the American Academy of Arts and Sciences.

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General Introduction

William A. Dembski and Michael Ruse

Intelligent Design is the hypothesis that in order to explain life it is necessary to suppose the action of an unevolved intelligence. One simply cannot explain organisms, those living and those long gone, by reference to normal natural causes or material mechanisms, be these straightforwardly evolutionary or a consequence of evolution, such as an evolved extraterrestrial intelligence. Although most supporters of Intelligent Design are theists of some sort (many of them Christian), it is not necessarily the case that a commitment to Intelligent Design implies a commitment to a personal God or indeed to any God that would be acceptable to the world's major religions. The claim is simply that there must be something more than ordinary natural causes or material mechanisms, and moreover, that something must be intelligent and capable of bringing about organisms.

Intelligent Design does not speculate about the nature of such a designing intelligence. Some supporters of Intelligent Design think that this intelligence works in tandem with a limited form of evolution, perhaps even Darwinian evolution (for instance, natural selection might work on variations that are not truly random). Other supporters deny evolution any role except perhaps a limited amount of success at lower taxonomic levels – new species of birds on the Galapagos, for instance. But these disagreements are minor compared to the shared belief that we must accept that nature, operating by material mechanisms and governed by unbroken natural laws, is not enough.

To say that Intelligent Design is controversial is to offer a truism. It is opposed, often bitterly, by the scientific establishment. Journals such as *Science* and *Nature* would as soon publish an article using or favourable to Intelligent Design as they would an article favourable to phrenology or mesmerism – or, to use an analogy that would be comfortable to the editors of those journals, an article favourable to the claims of the Mormons about Joseph Smith and the tablets of gold, or favourable to the scientific creationists' claims about the coexistence of humans and dinosaurs. Recently, indeed,

the American Association for the Advancement of Science (the organization that publishes *Science*) has declared officially that in its opinion Intelligent Design is not so much bad science as no science at all and accordingly has no legitimate place in the science classrooms of the United States.

Once one leaves the establishment and moves into the more popular domain, however, one finds that the level of interest in and sympathy for Intelligent Design rises rapidly. Many people think that there may well be something to it, and even those who are not entirely sure about its merits think that possibly (or probably) it is something that should be taught in schools, alongside more conventional, purely naturalistic accounts of origins. Students should be exposed to all sides of the debate and given a choice. That, after all, is the American Way – open debate and personal decision.

The editors of this volume, *Debating Design: Darwin to DNA*, fall at opposite ends of the spectrum on the Intelligent Design debate. William Dembski, a philosopher and a mathematician, has been one of the major contributors to the articulation and theory of Intelligent Design. He has offered analyses of design itself and has argued that no undirected natural process can account for the information-rich structures exhibited by living matter. Moreover, he has argued that the very features of living matter that place it beyond the remit of undirected natural causes also provide a reliable signature of design. Michael Ruse, a philosopher and historian of science, has long been an advocate of Darwinian evolution, and has devoted many years to fighting against those who argue that one must appeal to non-natural origins for plants and animals. He has appeared in court as an expert witness on behalf of Darwinism and has written many books on the subject.

For all their differences, the editors share the belief that – if only culturally – Intelligent Design is a significant factor on the contemporary landscape and should not be ignored. For the Intelligent Design proponents, it is a major breakthrough in our understanding about the world. For the Intelligent Design opponents, it is at the least a major threat to the status quo and something with a real chance of finding its way into classrooms. The editors also share the belief that, in a dispute such as this, it is important that the two sides have a real grasp of the opinions of those that they oppose. Ignorance is never the way to fight error.

There are of course already books that deal with Intelligent Design and with the arguments of the critics. The editors have themselves contributed to this literature. We believe, however, that there is virtue in producing one volume, containing arguments from both sides, in which each side puts forward its strongest case (previous volumes have tended to bias discussion toward one side over the other). The reader then can quickly and readily start to grasp the fundamental claims and counterclaims being made. Of course – and this is obviously an argument that comes more from the establishment – even doing something like this can be seen as giving one's

opponents some kind of status and legitimacy. And there is probably truth in this. But we do live in a democracy, and we are committed to working things out without resort to violence or to underhanded strategies, and so, despite the worries and fears, we have come together hoping that the merits of such an enterprise will outweigh the negative factors. Those who know how to do things better will of course follow their own principles.

The collection is divided into four main sections, with a shorter introductory section. The aim of the introductory section is simply to give the reader some background, and hence that section contains an overall historical essay by one of the editors, Michael Ruse, on the general history of design arguments – “The Argument from Design: A Brief History,” and then a second essay by Angus Menuge on the specific history of the Intelligent Design movement – “Who’s Afraid of ID? A Survey of the Intelligent Design Movement.” Although the first author has very strongly negative views on Intelligent Design and, as it happens, the second author has views no less strongly favourable, the intent in this introductory section is to present a background of information without intruding value commentary. The essays are written, deliberately, in a nonpartisan fashion; they are intended to set the scene and to help the reader in evaluating the discussions of the rest of the volume.

Michael Ruse traces design arguments back to the Greeks and shows that they flourished in biology down to the eighteenth century, despite the rethinking of issues in the physical sciences. Then David Hume made his devastating attack, but still it was not until Charles Darwin in his *Origin of Species* (1859) offered a naturalistic explanation of organisms that the design argument was truly rejected by many. The essay concludes with a discussion of the post-Darwinian period, showing that many religious people today endorse a “theology of nature” over natural theology. Most important in Ruse’s discussion is the distinction he draws between the argument to complexity – the argument that there is something distinctive about the organic world – and the argument to design – the argument that this complexity demands reference to a (conscious) designer to provide a full explanation. These are the issues that define the concerns of this collection.

Next, Angus Menuge provides a short history of the contemporary Intelligent Design movement and considers its future prospects. He notes that some, such as Barbara Forrest, dismiss the movement as stealth creationism. Menuge, however, finds this designation to be misleading. He argues that Intelligent Design is significantly different from typical creationist approaches in its aims, methods, and scope, and that scientists became interested in design apart from political or religious motivations. Thus he traces the roots of the Intelligent Design movement not to the political and religious zeal of anti-evolutionists but to the legitimate scientific critiques of evolution and origin-of-life studies in the mid-eighties by scientists such as Michael Denton and Walter Bradley. Yet because criticism by itself rarely

threatens a dominant paradigm, the Intelligent Design movement did not gain prominence until the work of Michael Behe (*Darwin's Black Box*, The Free Press, 1996) and William Dembski (*The Design Inference*, Cambridge University Press, 1998). These works outlined a positive program for understanding design in the sciences. Mengue concludes his essay by noting that regardless of whether Intelligent Design succeeds in becoming mainstream science, it is helping scientists to think more clearly about the causal pathways that account for the emergence of biological complexity.

We move now to the main sections, each of which has four or five contributions. We go from discussions favourable to evolution and critical of Intelligent Design, to discussions favourable to Intelligent Design and critical at least of unbroken evolution. The first such section, *Darwinism*, starts with a piece by the leading evolutionary biologist Francisco J. Ayala, a former Catholic priest and a person with great sensitivity to and sympathy for the religious attitude. In "Design without Designer: Darwin's Greatest Discovery," Ayala makes three claims. First, he claims that Darwin successfully brought the question of organic origins into the realm of science; second, that Darwin spoke to and solved successfully the question of complexity or adaptation; and third, that nevertheless there is something distinctive (something "teleological") about biological understanding even in the post-Darwinian world. The reader should refer back to the introductory essay of Michael Ruse to fit what Ayala is claiming into the division drawn between the argument to complexity (that Ayala thinks Darwin addresses and solves scientifically) and the argument to design (that Ayala thinks is now out of science but still carrying a form of argumentation that transfers over to modern science). Ayala concludes that science is not the only way of knowing.

Kenneth R. Miller, a scientist and a practicing Roman Catholic, is one of the strongest critics of Intelligent Design. In his contribution, "The Flagellum Unspun: The Collapse of 'Irreducible Complexity,'" Miller takes aim at one of the most important concepts promoted by Intelligent Design supporters, namely that of *irreducible complexity*. Introduced by Michael Behe in his *Darwin's Black Box*, this is a property possessed by certain aspects of organisms that supposedly could not be produced by unguided natural causes. It denotes something so overwhelmingly intricate and complex that it defies normal natural understanding and demands an explanation in terms of intelligence. Behe's prime biological example is of certain motorlike processes in microorganisms, and Miller's intent is to show that Behe is mistaken in his claims (as is Dembski in his support). Note that Miller explicitly asserts that his naturalistic position is more theologically satisfactory than that of his opponents.

Elliott Sober is a well-known philosopher whose piece – "The Design Argument" – is of a general nature. He is concerned to give a theoretical analysis of design arguments and particularly of arguments of the kind offered by Archdeacon William Paley (see Ruse's introductory chapter). He analyses

matters in terms of likelihood, that is, the idea of which of two hypotheses is more likely given a particular observation – in Paley’s case, an intelligence or blind chance given the discovery of a watch. Although Sober does not want to go all the way with Paley to the inference of a God (certainly not the Christian God), given his analysis he is more critical than most philosophers are of Hume’s arguments (especially inasmuch as they are analogical), but he is also not convinced that one can simply dismiss design arguments once Darwin appears on the scene. Having said this, however, Sober has little time for Intelligent Design, which he thinks fails as genuine science with respect to important properties such as prediction.

Finally in this section we have Robert Pennock, a well-known philosopher and critic of creationism (the author of *The Tower of Babel*) who argues that the Intelligent Design movement is built upon problematic religious assumptions. Considering the writings of Stephen Meyer (one of the contributors to this collection), Pennock takes up the claim that human dignity (and morality generally) can be justified only if the assumption that man is created in the image of God is factual. Pennock’s aim is to criticize not the belief in “the God hypothesis,” but rather the claim to have established it scientifically as an alternative to evolution. His essay critiques the theological presuppositions that he finds hidden in Intelligent Design, as well as the proposition that the design inference, interpreted as a scientific inference to the best explanation, confirms not just theism, but specifically the Judeo-Christian God. Along the way, Pennock points out problems with the recurring arguments that supporters of Intelligent Design use in their lobbying to get their view taught in the public schools.

The second section, *Complex Self-Organization*, contains pieces by those who believe that nature itself, simply obeying the laws of physics and chemistry without the aid of selection (or with, at best, a very limited contribution by selection), can produce entities showing the kind of complexity that Darwinians think can be produced only by their mechanism. This idea of “order for free” (as it has been termed by Stuart Kauffman) has a long history; its most notable exponent was the early twentieth-century Scottish morphologist D’Arcy Wentworth Thompson in his *On Growth and Form*.

The first piece in this section is by Stuart Kauffman himself. Here Kauffman tries to imagine what it would be like for biologists to develop what he calls a “general biology.” By a general biology Kauffman means a general theory of what it means to be alive and of how things that are alive originated. Kauffman concedes that we don’t at this time possess a general biology. According to Kauffman, a general biology would consist in principles that are applicable to all possible forms of life and that uncover their deep structure. The problem with natural selection, for Kauffman, is not that it is false or even that it is less than universally applicable. The problem is that natural selection cannot account for its own success (or, as he states it more precisely, cannot account for the “smooth fitness landscapes” that

enable it to be a “successful search strategy”). Kauffman’s essay attempts not to provide solutions but to ask the right questions. Implicit throughout the essay, therefore, is the admission that biology’s key conceptual problems remain to be solved. Kauffman thus differs from Darwinists who think that Darwin is the “Newton of the blade of grass.” At the same time, Kauffman does not think that Intelligent Design holds the solution to a general biology.

Next comes a chapter written jointly by the biologist Bruce H. Weber and the philosopher David J. Depew. In “Darwinism, Design, and Complex Systems Dynamics,” they argue that both strict Darwinians and Intelligent Design theorists are at fault for putting too heavy an emphasis on the design-like nature of the organic world (the argument to complexity, in the sense given earlier). They stress that it is possible to have functioning systems with many components that are far from perfect. The aim in nature is not to achieve some ideal standard, but simply to get things working at all. In this light, they feel that the natural processes of physics and chemistry can do far more than is often realized, and the authors make their case through a detailed discussion of the origin of life, something often downplayed in scientific discussions (especially those of Darwinians). As practicing Christians, Weber and Depew have a more-than-casual interest in the Intelligent Design debate, and their important concluding discussion points to the lack of a uniform Christian tradition giving unambiguous support for natural theology – that part of theology that stresses reason over faith and that focuses on arguments for the existence of God, such as the design argument (the second part of the distinction drawn earlier).

Paul Davies is one of the best known of all writers on the science–religion interface. His *God and the New Physics* is rightfully considered a classic. He is ever keen to show that the world works according to law, and yet for some time now he has been a critic of strict Darwinism, thinking that more is needed to explain life and its complexity. Mere selection will not do. (Unlike Weber and Depew, Davies has no trouble with the argument to complexity as such.) In “Emergent Complexity, Teleology and the Arrow of Time,” Davies explores the question of whether, balancing the negative downgrading effects of the Second Law of Thermodynamics, there is some kind of cosmic law of increasing complexity. He raises the contentious question of progress, something that has been much debated by evolutionists. Although it is not directly related to the question of possible design in the universe (in his *The Blind Watchmaker*, the arch-atheist Richard Dawkins argues for biological progress), for many thinkers (as Ruse notes in his introductory chapter) progress provides a new argument for God’s existence to replace the one (they believe to have been) destroyed by Darwin.

Finally in this section we have James Barham’s piece on the emergence of biological value. In it, he critiques what he calls the Mechanistic Consensus in contemporary scientific and philosophical thought. According to the Mechanistic Consensus, the theory of natural selection and molecular

biology suffice to explain the appearance of design in living things. This, he argues, is a mistake, because these disciplines make use of primitive concepts that are themselves normative and teleological in character. Furthermore, he argues, the widespread belief that the teleological language of biology is only “as if” and can be “cashed out” through reduction to lower-level physical theories is a mistake based on an outdated conception of physics itself. According to Barham, the best way to make scientific sense of biological design is not by looking to natural selection, and not by looking to an intelligent designer, but by looking to an emergent, purposive dynamics within living matter that allows organisms globally to coordinate their own activity so as to maintain themselves in existence as organized wholes. In this way, the living state of matter may be viewed as having intrinsic value. Some recent developments in nonlinear dynamics and condensed matter physics tending to support this view are briefly surveyed.

We come next to the section on *Theistic Evolution*. Here we find committed Christian believers who nevertheless want to find some place for evolution, although perhaps boosted by some kind of divine forethought or ongoing concern. John F. Haught is a distinguished Catholic writer on the science–religion relationship. His thinking is marked (he would say informed) by a sensitivity to the ongoing, unfurling nature of the world, something he finds explicable thanks not only to Christian theology but also to the philosophical thinking of Alfred North Whitehead, where the creation is not a once-and-for-all event, but rather something that is continuous and that God can try to influence and direct but cannot command. His chapter, “Evolution, Design and the Idea of Providence,” finds fault with both Darwinians and Intelligent Design supporters, feeling that both overstress the significance of design for an understanding of the Christian God (that is, overstress the significance of the second part of the twofold argument, the argument to design). Haught suggests that a God who is working in an ongoing fashion in the creation is truer to the Christian message than one conceived solely in the terms of traditional natural theology.

John Polkinghorne is both a distinguished physical scientist and an Anglican priest, which dual roles and interests have led him to be one of the most prolific writers in recent years on the science–religion relationship. He has long been an enthusiast for the “Anthropic Principle,” where it is the constants of the universe coming together in such a remarkable way to produce intelligent life that is the true mark of design. In the present essay, “The Inbuilt Potentiality of Creation,” Polkinghorne explores these ideas. His intent is positive rather than negative, but in a way his approach could be taken as implying that neither Darwinians nor Intelligent Design enthusiasts are focusing on the most important issues for understanding the Creator. In terms of the division of the argument for design into an argument for complexity and then an argument to design, Polkinghorne seems to accept the latter move but to feel that the real issue of complexity is not

biological adaptation but rather the specific physical phenomena that allow life – especially intelligent life – to exist at all.

Keith Ward is Regius Professor of Religion at the University of Oxford and another who has written extensively on theological issues in the light of modern science. In “Theistic Evolution,” he faces the issue that the world – the world of evolutionary life – cannot be something that simply occurred by chance. At least, for the Christian it cannot be something that simply occurred by chance. In some way, we must find space for purpose, for God’s intentions. Ward explores various ways in which this might be done. It is clear that (by implication) he would not look favourably on an Intelligent Design approach, for this would put God too directly into His creation. Ward wants God creating through the natural processes of law, and to this end he invites us to look sympathetically to the progressivist thinking of the French Jesuit paleontologist Pierre Teilhard de Chardin. But rather than Teilhard’s kind of vitalistic thinking, Ward inclines toward the idea that somehow God’s influence on nature stands in the same relationship as does the mind to the body. The two are intertwined, but in some way separate.

The Anglican priest and geologist Michael Roberts is interested in historical issues. Although he denies that he is committed to any kind of theistic evolution, he has as little sympathy for the hard-line materialistic Darwinian as he has for the Intelligent Design theorist. Through a study of the thinking of earlier scientists, particularly those interested in geology, he concludes that neither side has the true picture and that both are seduced by the rhetoric of their language and thinking. In some way, Roberts wants to break down the distinction between things working according to blind law (the stance of many Darwinians) and things working through miraculous intervention (the stance he attributes to Intelligent Design supporters). God is at work all of the time, through His laws. This means that He is never absent from the world – something that Darwinians are free to suppose is always true and that Intelligent Design proponents suppose, by default, is generally true.

Finally in this section we have Richard Swinburne of Oxford University. He, like Polkinghorne, sides with a version of the Anthropic Principle, although he approaches the issue from a more philosophical basis than does Polkinghorne, a physicist. In Swinburne’s thinking, it is all a matter of probabilities. Which is the more likely? That everything was set up to work by design, or that everything simply came together by chance? In Swinburne’s opinion, there is no doubt but that the intention-based explanation is better, from a simplicity perspective. In other words, like Polkinghorne, for Swinburne the Darwinian–Intelligent Design debate takes second place to an argument from design that begins with an argument to complexity that is not biologically based.

The final section turns to the proponents of *Intelligent Design*. The first piece is by William A. Dembski, in which he outlines his method of design

detection. If Intelligent Design is going to stand a chance of entering mainstream science, it must provide scientists with some rigorous way of identifying the effects of intelligent causation and of distinguishing them from the effects of undirected natural causes. Dembski claims to have provided design theorists with such a method in his criterion of specified complexity. The most common criticism made against using specified complexity to detect design is that it commits an argument from ignorance. In his chapter, Dembski answers this criticism by analyzing the logic by which specified complexity detects design. But he goes further, arguing that to reject specified complexity as a reliable empirical marker of actual design renders naturalistic theories of life's origin and history invulnerable to refutation, even in principle. His essay therefore attempts to level the playing field on which theories of biological origins are decided.

Walter L. Bradley is an engineer who specializes in polymers. In the mid-1980s, he coauthored what supporters consider a seminal critique of origin-of-life studies in *The Mystery of Life's Origin*. In that book, he distinguished between thermal and configurational entropy. That distinction has proven to be essential in relating the Second Law of Thermodynamics to the origin of life. The Second Law of Thermodynamics is widely abused. Some creationists have used it to provide a one-line refutation of any naturalistic attempt to account for life's origin. Alternatively, some evolutionists have treated the Second Law as a creative principle that provides a one-line solution to life's origin. Bradley is more careful and in his chapter delineates exactly how the Second Law applies to the origin of life. In particular, he updates his work on configurational entropy and clarifies how the crucial form of entropy that life must overcome is not thermal but configurational entropy.

The biochemist Michael J. Behe is the best-known scientific proponent of Intelligent Design. His chief claim to fame in his widely cited book published in 1996, *Darwin's Black Box: The Biochemical Challenge to Evolution*. In that book, he argued that the irreducible complexity of certain biochemical systems convincingly confirms their actual design. In this essay, Behe briefly explains the concept of irreducible complexity and reviews why he thinks that it poses such a severe problem for Darwinian gradualism. In addition, he addresses several misconceptions about how the theory of Intelligent Design applies to biochemistry. In particular, he discusses several putative counterexamples that some scientists have advanced against his claim that irreducibly complex biochemical systems demonstrate design. Behe turns the tables on these counterexamples, arguing that these examples in fact underscore the barrier that irreducible complexity poses to Darwinian explanations and, if anything, show the need for design explanations.

Finally, the philosopher of biology Stephen C. Meyer argues for design on the basis of the Cambrian explosion – the geologically sudden appearance of new animal body plans during the Cambrian period. Meyer notes that