

# THE DESIGN OF LIFE

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## *Discovering Signs of Intelligence in Biological Systems*

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The important thing in science is not so much to obtain new facts as to discover new ways of thinking about them.

—Sir William Lawrence Bragg

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# Preface

A decade has passed since *Of Pandas and People's* second edition appeared in print. Written by Percival Davis and Dean Kenyon, this book was the first intelligent design textbook. In fact, it was the first place where the phrase “intelligent design” appeared in its present use. Since the second edition of *Pandas*, intelligent design (or ID as it is now abbreviated) has gone from a small and marginalized protest against Darwinian evolution to a comprehensive intellectual program for reconceptualizing biology. Ten years ago intelligent design consisted mainly of sporadic criticisms of Darwinism and offered only vague glimmers of what a positive science of intelligent design might entail. Since then, intelligent design has laid the foundations for a general biology whose fundamental organizing principle is intelligent agency and not blind natural forces.

The impact of intelligent design is being felt both in the scientific community and in the culture at large. Front page stories in major newspapers like the *New York Times* are giving intelligent design respectful treatment (in their science section no less).<sup>1</sup> Television dramas, movies, and popular novels are exploring the theme of intelligent design. And of course, intelligent design is being fiercely debated throughout the academic world. Consequently, it is high time to issue a revised and expanded edition of *Pandas* that reflects the progress of intelligent design over the last ten years.

Darwinian theorists have long acknowledged that biological organisms “appear” to be designed. Oxford zoologist Richard Dawkins, a leading Darwinian spokesperson, has admitted, “Biology is the study of complicated things that give the appearance of having been designed for a purpose.”<sup>2</sup> Statements like this echo throughout the biological literature. Francis Crick, Nobel laureate and co-discoverer of the structure of DNA, writes, “Biologists must constantly keep in mind that what they see was not designed, but rather evolved.”<sup>3</sup> Nevertheless, Darwinists insist that this appearance of design is illusory because the mechanism of natural selection entirely suffices to explain the observed complexity of living things.

Over the last forty years, however, many evolutionary biologists have acknowledged fundamental problems with the Darwinian explanation for apparent design.<sup>4</sup> As a result, an increasing number of scientists have

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begun to argue that organisms *appear* to be designed because they really *are* designed. These scientists (known as *design theorists*) see evidence of actual intelligent design in biological systems. As their numbers have grown, their work has sparked a spirited scientific controversy over this central issue. They argue that, contrary to Darwinian orthodoxy, nature displays abundant evidence of real, not just apparent, design. For instance, mathematician William Dembski has published an important work on the theoretical underpinnings for detecting design. In *The Design Inference: Eliminating Chance Through Small Probabilities* (Cambridge University Press, 1998) he shows how design is empirically detectable and therefore properly a part of science.

Unlike contemporary neo-Darwinists, who deny evidence of real as opposed to merely apparent design, contemporary design theorists see impressive evidence of *actual* design in living systems. Biochemist Michael Behe is a case in point. His book *Darwin's Black Box* (Free Press, 1996) details the design constraints that organisms face at the biochemical level. Likewise, developmental biologist Jonathan Wells argues persuasively for design in embryological development.<sup>5</sup> Through his book *Icons of Evolution* (Regnery, 2000), Wells has also become the leading spokesperson for correcting textbook errors in the teaching of biological evolution.

The Foundation for Thought and Ethics is therefore extremely fortunate to have Dembski, Behe, and Wells join the original authors, Percival Davis and Dean Kenyon, in this sequel to *Of Pandas and People*. Though originally planned as a third edition of *Pandas*, *The Design of Life* quickly took on its own identity. More than half the material is completely new, and what remains of the original material has been completely revised and updated. Though there is continuity with the old book, *The Design of Life* is essentially a new book. As a supplemental text *The Design of Life* can be adapted to both high school and college biology courses. (High school and college teacher's guides are in preparation.)

The need for a book like this is as urgent as ever. Most contemporary biology textbooks act as though all serious debate about biological origins has long since ceased. Thus students get the impression that any challenge to Darwinism is a challenge to science and must be religiously motivated. But Darwinism is not the only available scientific account of biological origins. There is in fact a substantial scientific literature that critiques the adequacy of the Darwinian explanation for the complexity and "apparent design" of biological organisms.<sup>6</sup> Thus the debate—the *scientific* debate—over Darwinian evolution remains very much alive. This textbook

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provides students with an up-to-date overview of intelligent design and its contribution to that debate.

Jon A. Buell, President  
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+++++IMAGES+++++  
Covers of second edition of *Pandas*  
*New York Times* front page story on ID  
*Los Angeles Times* front page story (possibly)  
Cover of *The Design Inference*  
Cover of *Darwin's Black Box*  
Cover of *Icons of Evolution*  
=====IMAGES=====

# Note to Teachers

Biological origins is one of the most captivating subjects in the science curriculum. As a biology teacher, you have probably already seen how this topic excites students. The allure of dinosaurs, trilobites, fossilized plants, and ancient human remains is irresistible to many students. How did all these amazing life forms arise? How did life itself arise? Many prominent scientists owe their interest in science to such questions.

The subject of origins, however, is not only captivating. It is also controversial. Because it touches on questions of enduring significance, this topic has long been a focal point for vigorous debate—legal and political, as well as intellectual. Teachers often find themselves walking a tightrope, trying to teach good science while avoiding the censure of parents or administrators.

To complicate things further, controversies within the scientific community have compounded the cultural conflict. Since the 1970s, scientific criticisms of the long-dominant neo-Darwinian theory of evolution (which combines classical Darwinism with modern genetics) have surfaced with increasing regularity. Thus paleontologist Niles Eldredge was driven to remark.

If it is true that an influx of doubt and uncertainty actually marks periods of healthy growth in science, then evolutionary biology is flourishing today as it seldom has in the past. For biologists are collectively less agreed upon the details of evolutionary mechanics than they were a scant decade ago.<sup>1</sup>

Eldredge made this remark back in the 1985. The situation has not changed in the intervening years. In 2000 paleontologist Simon Conway Morris remarked, “When discussing organic evolution the only point of agreement seems to be: ‘It happened.’ Thereafter, there is little consensus.”<sup>2</sup>

But the controversy is not merely about details—it is systemic. David Depew and Bruce Weber contend that neo-Darwinian theory presents a fundamentally incomplete account of biological diversity and complexity.<sup>3</sup> The late Stephen Jay Gould put it even more bluntly, pronouncing the “neo-Darwinian synthesis” to be “effectively dead, despite its persistence as textbook orthodoxy.”<sup>4</sup> To be sure, Darwinism remains the majority view among biologists. But it is a beleaguered majority. It is certainly not the consensus.

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Similarly, materialistic accounts of chemical evolution (i.e., the origin of the first living cell) are a long way from resolving the problem of life's origin. Science writer Paul Davies goes so far as to suggest that any laws capable of explaining the origin of life must be radically different from any scientific laws known to date.<sup>5</sup> The problem, as he sees it, with currently known scientific laws, like the laws of chemistry and physics, is that they cannot explain the complex information-rich structures that are necessary for life.<sup>6</sup> Intelligent design, by contrast, promises to explain exactly such structures.

Though materialistic theories of life's origin and subsequent history continue to have many defenders, there is mounting evidence that all such theories already have entered a state of *paradigm breakdown*—a state where a once-dominant theory encounters such severe conceptual difficulties that it can no longer adequately explain many important data.<sup>7</sup> Science historians Earthy and Collingridge, for instance, describe neo-Darwinism as a paradigm that has lost its capacity to solve important scientific problems.<sup>8</sup> They note that both defenders and critics find it hard to agree even about what data are relevant to deciding scientific disagreements.

In such an intellectual and cultural climate, knowing how to teach biological origins is a challenge. Even so, it is not an insuperable challenge. Controversy can be turned to advantage. It gives teachers the opportunity to engage students at a deeper level. Instead of emphasizing isolated facts and vocabulary lists, teachers can show students the rough-and-tumble of genuine scientific debate. In this way, students learn how science really works. When they see scientists disagreeing over the interpretation of the same data, students learn how judgment, intuition, background assumptions, and critical thinking play a crucial role in science.

*The Design of Life: Discovering Signs of Intelligence in Biological Systems* is a supplemental text that takes students beyond the traditional scenarios offered in many basal biology textbooks. It encourages students to grapple with ideas as engaged participants in the scientific enterprise and not merely as uncommitted spectators. It gives students a much needed opportunity to explore the evidence and arguments that in the last decades have caused many scientists to doubt Darwinism. Going still further, this book helps students understand the positive case for intelligent design. *The Design of Life* offers a clear and cogent discussion of the latest scientific information you need to navigate the controversial waters of biological origins.

# Note to Students

In 1939 Ernest Vincent Wright wrote a novel called *Gadsby*.<sup>1</sup> Even though the novel's storyline was mind-numbingly dull, it had one remarkable feature: the letter *e* never appeared in it—not even once. Imagine you had to communicate with someone in English but could never use the letter *e*. You couldn't use common words like *the* or *we* or *are*. If your name contained the letter *e*, you couldn't even say your own name. Clearly, your ability to communicate would be seriously hindered. In fact, you'd be constantly thinking about how to get your point across without using the letter *e*.

Now let's ask an obvious question: Did Ernest Vincent Wright intentionally omit the letter *e* from his novel or was it unintentional? Was it just an accident that Wright never used the letter *e*? Did Wright finish his novel, scratch his head, and say: "Gee, that's strange. I never needed to use the letter *e* throughout my whole novel." But this is absurd. Of course Wright fully intended that the letter *e* never appear in his novel. The absence of the letter *e* was consciously planned and not an accident at all.

How do we tell when something is intentional, the result of a plan? How do we tell when something is unintentional, the result of an accident? Often there is no problem telling the difference because we know how the thing came about. Clouds driven by natural forces take shapes that are unintentional. On the other hand, a skywriter who writes in the clouds *Eat At Joe's!* is clearly acting intentionally. In such cases telling the difference between what is intentional and unintentional is obvious.

But what if we don't know how the thing in question came about? We weren't there when Ernest Vincent Wright wrote his novel. Let's say he never told anybody that he intended to write a novel in which the letter *e* never appeared. How, then, would we know that the absence of the letter *e* from his novel was intentional and not just accidental? In such cases we must appeal to *circumstantial evidence*.

Circumstantial evidence is a type of evidence that comes up in legal cases. The *American Heritage Dictionary* defines circumstantial evidence as follows: "Evidence not bearing directly on the fact in dispute but on various attendant circumstances from which the judge or jury might infer the occurrence of the fact in dispute."<sup>2</sup> The *Concise Oxford Dictionary* expands on this definition: "[Evidence that tends] to establish a conclusion by inference from known facts hard to explain otherwise."<sup>3</sup>

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It is hard to explain the absence of the letter *e* from Ernest Vincent Wright's novel apart from his conscious intention to omit it. The letter *e* is the most commonly occurring letter in the English alphabet. Over ten percent of all the letters that appear in books, magazines, and newspapers are the letter *e* (including this book!). It is therefore exceedingly improbable that Wright could have written *Gadsby* and merely by chance omitted the letter *e*.

Circumstantial reasoning and evidence like this comes up not only in the courts but also in science. Often in science, we don't have direct access to the facts under dispute. Instead, we must employ circumstantial evidence. Circumstantial evidence is always indirect. But that doesn't make it any less compelling. A murder committed in the presence of many witnesses and recorded on a video camera provides direct evidence of the identity of the murderer. But fingerprint and DNA evidence, which is always indirect and therefore circumstantial, can also provide compelling evidence of guilt.

The study of biological origins is a matter of sorting through circumstantial evidence. No scientist was there when life originated or when the first multicellular organisms came into being or when the first humans appeared. Nor were any video cameras running. The evidence for biological origins is spotty and indirect—in other words, it is circumstantial. Nevertheless, it is possible to reconstruct the history of life in broad strokes. Moreover, it is possible to determine whether living forms exhibit clear signs of intelligence and therefore design.

The absence of the letter *e* from Ernest Vincent Wright's novel was clearly intentional and therefore designed. So too, the authors of this book will argue, life exhibits clear signs of intelligence or design. This claim is controversial. Many biologists, following Darwin's theory of natural selection and random variation, claim that even if life looks intended, there is ultimately no intention or design behind it. A major part of this book, therefore, is to lay out the circumstantial evidence that bears on biological origins and to provide a logical framework within which to make sense of that evidence.

This book, then, is about the circumstantial evidence for Darwinism and design in biology as well as the proper interpretation of that evidence. But it is about much more. According to Carl Sagan,

As long as there have been human beings, we have posed the deep and fundamental questions, which evoke wonder and stir us into at least a tentative and trembling awareness, questions on the origins of consciousness; life on our planet; the beginnings of the Earth; the formation of the Sun; the possibility of intelligent beings

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somewhere up there in the depths of the sky; as well as, the grandest inquiry of all—on the advent, nature and ultimate destiny of the universe.<sup>4</sup>

The origin of biological systems is one of Sagan's "deep and fundamental questions." This book will help you sort through the scientific issues connected with that question.

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## Epilogue: The “Inherit the Wind” Stereotype

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Critics of intelligent design frequently portray anyone who is willing to consider alternatives to Darwinian evolutionary theory as religiously motivated opponents of science. Using a stereotype epitomized in the Hollywood film *Inherit the Wind*, a fictional portrayal of the 1925 Scopes “Monkey Trial,” many in the academy and media treat any challenge to Darwinism as a challenge to truth and rationality. Yet it is the failure to examine evolutionary theory critically that poses the real challenge to truth and rationality.

Jerome Lawrence and Robert Lee wrote the play *Inherit the Wind* in the 1950s. It was produced on Broadway in 1955, but is best known as a 1960 black-and-white movie starring Spencer Tracy and Frederic March. A more recent version of the movie, made in 1999, starred Jack Lemmon and George C. Scott, but the 1960 version has been far more influential (you should be able to find it in the “classics” section of your local video rental store).

Like the Scopes trial, the play is set in 1925. In it, Bert Cates (the John Scopes character) is hounded by religious fundamentalists in the town of Hillsboro (which corresponds to Dayton, Tennessee) for teaching Darwin’s theory of evolution. Henry Drummond (who corresponds to famous defense attorney Clarence Darrow) bravely offers to defend Cates. To offset Drummond and suppress the spread of evolutionary ideas, narrow-minded Matthew Harrison Brady (the fictional double of popular political figure William Jennings Bryan) offers to prosecute Cates.

While *Inherit the Wind* makes for fine storytelling, it makes for atrocious history. Cates (Scopes) is supposedly in danger of being imprisoned and losing all that’s dear to him (especially the woman he loves) because of his stand for evolution. In fact, the real Scopes was never in such danger and agreed to take part in the trial because local

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boosters put him up to it. They thought an “evolution-monkey trial” would put the town of Dayton Tennessee on the map—which it did! Scopes was a physical education teacher who taught biology part-time. Local prosecutors agreed to go along with the charade.

Things got out of hand when Clarence Darrow offered to defend Scopes and William Jennings Bryan volunteered to speak for the prosecution. Darrow was not only a famous trial lawyer but also a nationally recognized lecturer who promoted agnosticism and argued publicly against religion. Bryan, unlike Brady in the play, was not a reactionary or a fundamentalist. Bryan was a three-time Democratic presidential candidate and a progressive politician who sought to protect farmers and blue-collar workers from exploitation by big business. Unlike Brady in the play, Bryan did not interpret the book of Genesis literally. Bryan opposed Darwinism because he saw it as justifying unrestrained capitalism, as well as the militarism that led to World War I.

In 1997, Edward Larson, a University of Georgia professor in the history of law, published a critical reassessment of the Scopes Trial. In *Summer for the Gods: The Scopes Trial and America's Continuing Debate Over Science and Religion*, Larson thoroughly deconstructed *Inherit the Wind*, showing just how badly the “Scopes Trial” stereotype misrepresents the actual Scopes Trial. The book shows that the debate over biological origins was—and is—far more complex than most Americans have been told. For his book, Larson was awarded the 1998 Pulitzer Prize in history.

In the actual Scopes trial, evolution, and the evidence for it, were never subjected to any cross-examination. Scopes's lawyers presented extensive written statements from seven scientists stating that evolution is the correct explanation for the diversity of life on earth.<sup>1</sup> Statements of Drs. Metcalf, Nelson, Lipman, Judd, and Newman were read in court; statements of Drs. Cole and Curtis were also submitted in writing. The prosecution sought permission to cross-examine the five pro-Darwinian science experts whose statements were read in open court, but Darrow and the other Scopes lawyers objected, and the court refused to allow it.<sup>2</sup>

Certainly, the most dramatic aspect of the Scopes trial was Darrow's questioning of Bryan about the Bible. But this raises an obvious question: given that Darrow got to question Bryan about the Bible, why didn't Bryan get to question Darrow about evolution? In fact, Bryan agreed to be questioned by Darrow on his personal interpretation of the Bible *only if* Darrow agreed to be questioned on the evidence for evolution. What's more, the court agreed that Bryan could question Darrow after Darrow questioned Bryan.<sup>3</sup> But, at the conclusion of his famous examination of Bryan, Darrow unexpectedly changed Scopes's plea to guilty. That closed

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the evidence and made it impossible for Bryan to call Darrow to the stand to question him on evolution.<sup>4</sup>

Darrow could easily have changed the plea before his examination of Bryan (in which case Bryan's defense of the Bible would never have made it into the trial transcript) or after Bryan examined him (in which case Darrow's defense of evolution would also have made it into the trial transcript). But by changing the plea *right after* he examined Bryan and *despite* agreeing that Bryan could examine him next about evolution, Darrow made clear that his intention all along was to question Bryan and then escape questioning himself.

The result was that in the Scopes trial, scientists presented their case for evolution without any challenge. Evolutionary theory has a long history of evading critical scrutiny and escaping proper cross-examination. The late Fred Hoyle, founder of the Institute for Astronomy at Cambridge, did not mince words when he remarked that scientific challenges to evolution have "never had a fair hearing" because "the developing system of popular education [from Darwin's day to the present] provided an ideal opportunity ... for awkward arguments not to be discussed and for discrepant facts to be suppressed."<sup>5</sup>

The fact is that evolution, as taught in 1925, was eminently deserving of critical scrutiny and cross-examination. Back then, Darrow denounced opponents of Darwinian evolution as "bigots and ignoramuses" trying to "control the education of the United States."<sup>6</sup> Stereotypes like this, however, cut both ways. According to Harvard law professor Alan Dershowitz, those in 1925 who advocated for evolution included "racists, militarists, and nationalists" who used evolution "to push some pretty horrible programs" including the forced "sterilization of 'unfit' and 'inferior'" people; "the anti-immigration movement" that wanted to bar immigration of people of "inferior racial stock"; and "Jim Crow" laws that evolutionists "rationalized on grounds of the racial inferiority of blacks."<sup>7</sup>

Dershowitz goes on to note that the very textbook Scopes taught to high school students, Hunter's *Civic Biology*, divided humanity into five races and ranked them in terms of superiority, concluding with "the highest type of all, the Caucasians, represented by the civilized white inhabitants of Europe and America." *Civic Biology* also advocated that crime and immorality were inherited and ran in families, and that "these families have become parasitic on society.... If such people were lower animals, we would probably kill them off.... [W]e do have the remedy of separating the sexes in asylums or other places and in various ways preventing intermarriage and the possibilities of perpetuating such a low and degenerate race."<sup>8</sup> The lab book for Hunter's text, at Problem 160,

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asks students to use inheritance charts “[t]o determine some means of bettering, physically and mentally, the human race.” What’s more, a “note to teachers” says that “[t]he child is at the receptive age and is emotionally open to the serious lessons here involved.”<sup>9</sup>

Of course, the scientific community today denounces all such biological racism. Nonetheless, some prominent contemporary Darwinists, like Daniel Dennett, are so assured of the truth of Darwinism that they now embrace a cultural elitism in which anyone who dissents from Darwinian orthodoxy is regarded as culturally substandard and in need of being segregated from the culturally acceptable people who embrace Darwinism. Dennett, for instance, advocates that children be forced to learn that they are “the product of evolution by natural selection” because “our future well-being depends on the education of our descendants.”<sup>10</sup> Moreover, he advises that parents who stand in the way of such enforced education be quarantined: “Those whose visions dictate that they cannot peacefully coexist with the rest of us we will have to quarantine.”<sup>11</sup>

But consider, the very textbook from which Scopes taught—the very book that today’s scientific community insists Scopes had the absolute right to teach public school students—includes material that today’s scientific community passionately rejects. Imagine a hypothetical 1925 state law—a law that permitted the teaching of eugenics as the scientific community of the time demanded, but also required that challenges to that theory be taught. Would not everyone today applaud the foresight of any state that had enacted such a law? Hear, hear! Let the science of the day have its say, but then teach the weaknesses and criticisms of it.

This hypothetical example of a state law that mandates the critical examination of the “science” of eugenics demonstrates that it is appropriate for those who oversee our school science curricula not to be slavishly bound to whatever the scientific community espouses at the moment. The population at large—who are free from institutional incentives and professional biases—are entirely in their rights to question a scientific theory regardless of how confidently the scientific community espouses it.

Indeed, if the history of science is any indicator, every scientific theory has faults and is eventually abandoned in favor of a better, more accurate theory. Why should we expect any different from evolutionary theory? A scientist’s confidence in a theory is no guarantee that it is true. As Nobel prize winning biologist Peter Medawar put it, “I cannot give any scientist of any age better advice than this: the intensity of the conviction that a hypothesis is true has no bearing on whether it is true or not. The importance of the strength of our conviction is only to provide a

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proportionally strong incentive to find out if the hypothesis will stand up to critical examination.”<sup>12</sup>

To discredit those who opposed the teaching of Hunter’s *Civic Biology* in 1925, mainstream scientists and media figures insisted that religious convictions were the only motive for opposing that textbook. Dershowitz notes that even the U.S. Supreme Court agreed with the evolution-inspired eugenics program, upholding a mandatory sterilization law on the view that “three generations of imbeciles are enough.”<sup>13</sup> But fortunately for civil rights in America, intelligent, inquiring people of good will (not “religious fanatics” or “opponents of science”) questioned the reprehensible teachings of Hunter’s *Civic Biology*. And fortunately, too, enough people were willing to consider both the official position of science and—to borrow a phrase from another and more recent Hollywood film—the “minority report.”

So too, in our own day, intelligent, inquiring people of good will (not opponents of science and not Daniel Dennett’s cultural inferiors) can question the teaching of Darwinian and other naturalistic forms of evolution. It is entirely legitimate, both intellectually and scientifically, to question whether evolution operates exclusively by means of unintelligent, purely mechanistic processes like natural selection. Far from repeating the oneness of the Scopes Monkey Trial, the approach embodied in this textbook remedies it. It does so by providing the kind of cross-examination that the Scopes science experts and lawyers should have had to face, but conveniently avoided.

Proponents of intelligent design do not argue that evolution and the evidence for it must be suppressed because of some alleged conflict with the Bible. Instead, they argue that evolution—specifically, the theory that evolution occurs exclusively by means of undirected mechanistic processes such as natural selection and random variation—may legitimately be questioned because the scientific evidence used to support it is weak. Noted neo-Darwinist Theodosius Dobzhansky asserted, “Nothing in biology makes sense except in the light of evolution.”<sup>14</sup> In fact, nothing in biology makes sense except in the light of *evidence*.

Where does the evidence of biology lead, to unguided evolution or to intelligent design? This textbook, in telling students about the evidence and arguments for intelligent design, provides students with the information they need to answer this question. Providing this information is not just pedagogically sound but also legally permissible. In 1987, the U.S. Supreme Court ruled in *Edwards v. Aguillard* that “teaching a variety of scientific theories about the origins of humankind to school children might be validly done with the clear secular intent of enhancing the

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effectiveness of science instruction.”<sup>15</sup> By telling about the evidence and arguments for intelligent design, science educators help fulfill that Supreme Court mandate. But they do more. They also foster the true spirit of scientific inquiry.

## Endnotes

### Preface:

<sup>1</sup>James Glanz, “Biologists Face a New Theory of Life’s Origin,” *New York Times* (Sunday, 8 April 2001): 1, 18.

<sup>2</sup>Richard Dawkins, *The Blind Watchmaker: Why the Evidence of Evolution Reveals a Universe Without Design* (New York: Norton, 1987), 1.

<sup>3</sup>Francis Crick, *What Mad Pursuit* (New York: Basic Books, 1988), 138.

<sup>4</sup>See David J. Depew and Bruce H. Weber, *Darwinism Evolving: Systems Dynamics and the Genealogy of Natural Selection* (Cambridge, Mass.: MIT Press, 1995).

<sup>5</sup>For a popular exposition of Wells’s views on this topic, see his article “Making Sense of Biology: The Evidence for Development by Design” in William A. Dembski and James M. Kushiner, eds., *Signs of Intelligence* (Grand Rapids, Mich.: Brazos, 2001), 118–127.

<sup>6</sup>See the thirty-page bibliography in Depew and Weber, *Darwinism Evolving*, 531–564.

### Note to Teachers:

<sup>1</sup>Niles Eldredge, *Time Frames: The Evolution of Punctuated Equilibria* (Princeton: Princeton University Press, 1985), 14.

<sup>2</sup>Simon Conway Morris, “Evolution: Bringing Molecules into the Fold,” *Cell* 100 (7 January 2000): 1–11.

<sup>3</sup>David J. Depew and Bruce H. Weber, *Darwinism Evolving: Systems Dynamics and the Genealogy of Natural Selection* (Cambridge, Mass.: MIT Press, 1995), 479.

<sup>4</sup>Stephen Jay Gould, “Is a New and General Theory of Evolution Emerging?” *Paleobiology* 6 (Winter 1980): 119–130.

<sup>5</sup>Davies claims that we are “a very long way from comprehending” how life originated. “This gulf in understanding is not merely ignorance about certain technical details, it is a major conceptual lacuna.... My personal belief, for what it is worth, is that a fully satisfactory theory of the origin of life demands some radically new ideas.” Paul Davies, *The Fifth Miracle: The Search for the Origin and Meaning of Life* (New York: Simon & Schuster, 1999), 17.

<sup>6</sup>*Ibid.*, 115–122. See also Michael Polanyi, “Life Transcending Physics and Chemistry,” *Chemical and Engineering News* (21 August 1967): 55–66; and Michael Polanyi, “Life’s Irreducible Structure,” *Science* 113 (1968): 1308–1312.

<sup>7</sup>See William A. Dembski, *No Free Lunch: Why Specified Complexity Cannot Be Purchased without Intelligence* (Lanham, Md.: Rowman and Littlefield, 2001), which presents a general argument against the power of materialistic mechanisms to generate certain types of biological complexity.

<sup>8</sup>D. Collingridge and M. Earthy, “Science under Stress: Crisis in Neo-Darwinism,” *History and Philosophy of the Life Sciences* 12 (1990): 3–26.

**Note to Students:**

<sup>1</sup>Ernest Vincent Wright, *Gadsby* (Los Angeles: Wetzel, 1939).

<sup>2</sup>*The American Heritage Dictionary of the English Language*, 3rd ed. (Boston: Houghton Mifflin, 1992), 347, s.v. “circumstantial evidence.”

<sup>3</sup>*Concise Oxford Dictionary of Current English*, 8th ed. (Oxford: Oxford University Press, 1990), 204, s.v. “circumstantial.”

<sup>4</sup>Carl Sagan, *Broca's Brain* (New York: Random House, 1974), from the introduction.

**Epilogue:**

<sup>1</sup>See *The Scopes Trial*, 229-280. The verbatim transcript of the Scopes Trial was published in 1925 by the National Book Company and then reprinted 1990 by Gryphon in their *Notable Trials Library* series. The transcript is available at <http://www14.inetba.com/gryphon/item43.ctlg> (last accessed 6 February 2003).

<sup>2</sup>*Ibid.*, 206, 220-221, 223. The prosecution is partly responsible for the failure of evolution to undergo cross-examination in the Scopes Trial. According to the prosecution, the Tennessee statute outlawed the teaching of evolution regardless of whether evolution was true, and thus all evidence for the truth of evolution was irrelevant and should be excluded. The judge agreed, and initially kept the scientists from testifying, which meant, of course, that the prosecution lost its initial opportunity to cross-examine them. It was later that the judge allowed the scientists' written testimony to be read in open court, but then denied the prosecution any chance to challenge that testimony. Yet, once that testimony was admitted into the proceedings, the truth of evolution did become an issue, and fairness required that it be subjected to cross-examination.

<sup>3</sup>*Ibid.*, 284, 288.

<sup>4</sup>*Ibid.*, 306-307.

<sup>5</sup>Fred Hoyle, *Mathematics of Evolution* (Memphis, Tenn.: Acorn Enterprises, 1999), 106.

<sup>6</sup>*The Scopes Trial*, 299.

<sup>7</sup>*The Scopes Trial*, introduction by Alan Dershowitz.

<sup>8</sup>*A Civic Biology* presents studies of two families—the Jukes family and the Kallikak family. The Jukeses are said to descend from “Margaret, the mother of criminals,” and to have cost New York in the period of 75 years “the care of prisons and asylums of considerably over a hundred feeble-minded, alcoholic, immoral, or criminal persons.” The Kallikaks are said to descend from Martin Kallikak and “a feeble minded girl” whose 480 descendants include “33 sexually immoral, 24 confirmed drunkards, 3 epileptics, and 143 *feeble-minded*. The man who started this terrible line of immorality and feeble-mindedness later married a normal Quaker girl. From this couple a line of 496 descendants have come, with *no* cases of feeble-mindedness. The evidence and the moral speak for themselves!” These and other quotes from *Civic Biology* are available on the Internet: <http://www.eugenics-watch.com/roots/chap08.html> and [http://www.iit.edu/departments/humanities/impact/colloquium/ongley\\_2001f.html](http://www.iit.edu/departments/humanities/impact/colloquium/ongley_2001f.html).

<sup>9</sup>Hunter, *Laboratory Problems in Civic Biology*, 182. Ironically, in light of this epilogue, the lab book contains nothing on evolution. Apparently, Hunter and his

publishers felt it was more important for the “receptive” young students of 1925 to learn eugenics than to learn evolution.

<sup>10</sup>Daniel Dennett, *Darwin's Dangerous Idea* (New York: Simon & Schuster, 1995), 519.

<sup>11</sup>Ibid.

<sup>12</sup>Peter B. Medawar, *Advice to a Young Scientist* (New York: Basic Books, 1981), 39.

<sup>13</sup>So wrote Justice Oliver Wendell Holmes in 1927 in the case of *Buck v. Bell*.

<sup>14</sup>Theodosius Dobzhansky, “Nothing in Biology Makes Sense Except in the Light of Evolution,” *The American Biology Teacher* 35 (1973): 125-129.

<sup>15</sup>*Edwards v. Aguillard*, 482 U.S. 578 (1986), 594.