The Panda's Black Box

OPENING UP THE INTELLIGENT DESIGN CONTROVERSY

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Untangling Debates about Science and Religion

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In September 2005, I entered the Federal Building and U.S. Courthouse in Harrisburg, Pennsylvania, and joined a line of citizens passing through security and heading to the hearing rooms upstairs. Nearly everyone was there for the case of *Kitzmiller v. Dover Area School District*, being heard by Judge John E. Jones III. I was there at the request of the Federal Judicial Center's Education Division to lead an all-day seminar on science and social issues surrounding embryo research, including cloning and stem cells. One of the judges in my seminar commented that conflicts about science and religion seem never to go away, but that the same old debates just emerge in new forms. He wasn't sure that anybody ever really learns anything along the way, though I am a bit more hopeful than he.

At lunch, we joined Judge Jones, who felt it was already very clear what should count as good science and also that for constitutional reasons science and not religion should be taught in schools. We all agreed that the public is often given the impression that what is at stake is a simple battle of science versus religion—as if that were just one straightforward debate and as if it were just a matter of determining which of two clearly defined sides will win. Was the *Dover* trial (or are the apparently similar debates concerning whether to

allow human embryonic stem cell research in the United States) simply a straightforward controversy over whether science or religion will win?

The answer, of course, is yes. But not really. Or not only. The Intelligent Design controversy, like the stem cell controversy, is a tangle of debates over several distinct questions operating on very different levels. Some of these can be resolved with increased understanding and communication, through various versions of compatibilism or translation between science and religion. Some of the issues are superficial. Some come from deep and abiding differences in underlying assumptions and are irresolvable. By laying out the tangle of issues more clearly and separating the various threads, we can promote tolerance and enlightenment rather than intolerance and misrepresentation.

There are two different kinds of unificationist extremists: those advocating religion as an ultimate arbiter and unifier that provides morals and metaphysics, and those advocating all and only science all the time and denying any role for other values or views in modern society. Both hold to their convenient coherent worldviews and their tightly woven tangle of views. Each denies authority to others with competing views, and they allow no room for compromise or compatibilism. These are the extremes, and most people lie in between.

On the one side, ID proponents, like their "creation science" predecessors, create confusion about what is really meant by science and by religion and then take excellent advantage of the resulting confusion. They demand that we, as a society, teach "the controversy"—as if it were clear what that is. The media then take up the call for understanding the controversy about science and religion in the form of evolution and creationism, and demand "balance" without understanding across which variables there must be balance. Public discussion then swirls about "the" debate and "the" controversy. The same thing has happened with those demanding protection for embryos that they define as persons and over which definition they claim to have moral authority, and they portray

themselves as in opposition to those who want to do research. It is instructive to look at these two cases.

At the same time, as Michael Ruse has energetically pointed out, including quite publicly and personally in an email exchange with Dennett posted on the blog Uncommon Descent, ardent anti-religion evolutionists like Richard Dawkins and Daniel Dennett do not help the situation.[1] In such books as Dennett's *Breaking the Spell* and Dawkins's *Blind Watchmaker*, they paint their pictures in terms as stark as those of the creationists, suggesting that evolutionary science is good and science is right on all matters, and that there is neither need nor room for religion. We also find Nobel laureates such as geneticist Paul Berg recently giving a distinguished lecture at Arizona State University's Law School, and stumping energetically for stem cell science. He claimed that all scientific research is good and that there is even a constitutional right to free inquiry through research. Both those opposing the particular science in question and those advocating all and only science as good call for laying out and playing out "the" controversy. Extremists on both sides seem to want either religion or science clearly to win. The evolution-creationism debate, the stem cell debate, the . . . fill-in-the-blank science-versus-religion/morality debate: each is taken as a straightforward us-versus-them set of polarities.

There is danger in not untangling the web of beliefs. If we allow the false impression that there is a simple controversy at work here, the group with the most unified, simplistic, and unchanging set of premises has the easiest position to argue. Those holding an apparently coherent and nicely integrated view resist untangling the intertwined threads that make up their "worldview," and the apparently integrated coherence and the certainty and ardor with which its advocates hold the view are seductive to many. Even for those of us who choose to embrace no religion, or those of us who feel that pre-implantation embryos are just cells "in a dish," it is important to realize the range of views and the reasonableness of some of them but not others—and to develop a set of socially shared criteria for

which views are reasonable and which are not. Above all, it is important to recognize and embrace the complexity of the natural and the social worlds. "It is," as Darwin noted on the last page of his 1859 *Origin*, "interesting to contemplate a tangled bank, clothed with many plants of many kinds, with birds singing on the bushes, with various insects flitting about, and with worms crawling through the damp earth, and to reflect that these elaborately constructed forms, so different from each other, and dependent upon each other in so complex a manner, have all been produced by laws acting around us."[2] That bank is tangled with a natural world of organisms and also a social context of metaphysical, epistemological, and moral assumptions.

Untangling the bank brings understanding of the fundamental natural laws and social practices that govern its existence. As thinkers from Isaac Newton to the philosophes to current scientists have agreed, science such as evolution provides our best available approach and methods for understanding and explaining the natural bank. Indeed, as Darwin continued in his last paragraph, "There is grandeur in this view of life, with its several powers, having been originally breathed into a few forms or into one; and that, whilst this planet has gone circling on according to the fixed law of gravity, from so simple a beginning endless forms most beautiful and most wonderful have been, and are being evolved."

Yet this is not to argue that there can be nothing beyond science and the material, nor that through science we have any way of knowing what might or might not be beyond the natural material world. In the later editions of the *Origin*, Darwin himself allowed—at least logically—for both the natural laws of science and for a creator. In later editions, he revised his final clause to: "having been originally breathed by the Creator into a few forms or into one." There can be room for science and a creator, as long as the roles are carefully and clearly untangled and defined. There is room for a "god of the gaps," as the role has come to be called.

Let me be perfectly clear what is not at issue. From the perspective of the biological sciences, there is absolutely no question that a

form of evolution of species by natural evolution has occurred, including evidence that the human species has arisen through a process of natural selection and other natural forces. Furthermore, we would be foolish to behave or believe otherwise because there are consequences in not accepting this understanding brought by an overwhelming mass of scientific evidence. There is too much at stake in human evolution and what we can expect for our future not to accept this scientific evidence that evolution has occurred and explains how the organic world got to be this way. Many, many converging lines of evidence support this conclusion. We do not have the whole story yet, of course, nor should we expect to. But the coherent picture that emerges and that is reinforced by new discoveries is completely unambiguous scientifically. Scientifically, there is no controversy. A large number of churches recognize this fact, as seen on February 12, 2006, which became "Evolution Sunday." This is not the place to rehearse the case for evolution. There is no scientific controversy, and as Kenneth Chang showed in the *New York Times*, even the feeble attempts to claim that "scientists" question whether evolution has occurred center on short lists of engineers and nonbiologists who are said to have questions.[3] There is no doubt, there is no evidence against evolution, and there is no controversy about the science of evolution.

SCIENCE VERSUS RELIGION: WHY THE CASE OF HUMAN EMBRYONIC STEM CELLS IS RELEVANT

Arguments about human embryonic stem cell research and whether we should allow it, fund it publicly, regulate it, or prohibit it altogether play out in similar ways, though some of what is at issue is different. Let us be very clear here as well. "The" debates are not about science versus morality, which is (falsely) assumed by some to come only from religion. This is not about choosing between the wishes of wild-eyed scientists to do research no matter what versus the wise and moral superiority of those who would protect the most innocent of human lives. Yet the public presentation often makes it

seem that the issues are the same: science versus morality or religion. Again, we need to untangle issues.

In the case of embryos, what biology shows is that there is a point in time for each individual organism, under normal circumstances, when an egg cell is fertilized by a sperm cell and that zygote begins to split into more and more cells. Biological research makes it clear that the earliest divisions divide material and do not produce growth or any significant gene expression. Cells just divide into smaller parts. This continues up to the blastocyst stage, at which point most of the cells divide quickly into more and more small cells that are called the embryonic stem cells and that make up an inner cell mass. This is surrounded by a single layer of cells that will eventually make up the placenta. At this stage, the preimplantation embryo is called a blastocyst.

This stage in human development is a ball of cells bouncing around in the mother's uterus and just beginning to move toward implantation in the uterine wall, or else the blastocysts are in the "dish" in a fertility clinic where some will be placed into a potential mother for implantation, others will be frozen for later implantation, while still others will be discarded. At this point in the history of biological research, human blastocysts cannot develop further and cannot begin differentiation without having become implanted in the mother. This is the biological knowledge, clearly explained by leading developmental biology textbooks such as Scott Gilbert's and by educational explanations about stem cells on the NIH website;[4] the science is as well founded and as solidly grounded and unquestioned as evolution.

Further, as far as we know, every one of these stem cells in the blastocyst stage of the embryo before implantation is capable of becoming any one—but not all—of the different types of cells that make up the body. Hence each is considered pluripotent, with plural potencies, but it is not totipotent since it cannot become a whole organism by itself. Which type of cell any one pluripotent cell will become in normal conditions depends on signaling among all the cells in the individual organism, and that depends on each cell's environ-

ment. Researchers have discovered that by controlling the environment of each cell, through different cell culture media, they can cause each undifferentiated cell to multiply and generate a cell line and also with different media to become differentiated as different types of cells.

There is no disagreement about the major facts. Of course, researchers are making new discoveries and adding tremendously to our knowledge, as they are in understanding the details of how evolution works. But there is no scientific controversy here. Biological researchers agree that we can and should learn more about how development and differentiation occur. Nobody seriously argues that we should not seek to gain further knowledge about embryos. Understanding is good in science.

The discovery of these pluripotent cells is also exciting for potential therapeutic applications for two reasons: first because researchers might actually be able to culture specific desired types of cells for medical use, and second because study of these cells and what makes them differentiate in different ways informs our understanding of how we might produce particular kinds of cells with the right engineering. The potential is clear and well established, though we do not yet know what it is actually possible to do with human embryonic stem cells.

Controversies begin to arise, however, when we ask which research *should* be done and how. Should we study human development by taking human blastocysts and harvesting stem cells in order to study them? Right now, the only way we know how to study human embryonic stem cells is to open up the blastocyst and remove the cells. This stops any further development of the blastocyst. Harvesting embryonic stem cells therefore necessarily "kills" the embryo. Science—as science—entails no view about whether this is a morally bad or good thing. Scientifically, for purposes of understanding more about nature through science, the act can be "good" (in the sense of justified) if harvesting stem cells produces reliable new knowledge. In the strictest sense of science, then, there is—there can be—no controversy over stem cell research. Controversy

comes from our metaphysical and moral interpretations, which lie outside of science. For some, embryos at the blastocyst stage are persons or potentially persons, and therefore deserve protection and at least the "respect" not to have research done on them. For others, at this early stage these are just cells in the dish. Biology tells us very clearly what the cells can do and what they can do by virtue of being together, as an organism. Biology cannot tell us whether these cells should be considered persons or what moral, legal, or religious interpretations we should have about them. Society as a whole has to do that, and the attempts to do so have been much disputed in many overlapping and cross-cutting debates outlined in numerous books, articles, and websites.

That is to say, we develop a socially accepted metaphysics. As a society, we accept that there is a natural world, made up of natural objects that consist of matter and motion. Nobody denies that, not really. As Boswell noted in his *Life of Johnson*, when Bishop Berkeley confronted Samuel Johnson with arguments that matter might not really exist, Johnson reportedly kicked the large stone nearby and exclaimed, "I refute it thus." Matter exists and it is kicked by external agents or it moves and changes (or develops or evolves) under certain conditions. What is less easily demonstrated is the metaphysical claim that there is more to the world than that matter and its motion. Perhaps there is also a set of supernatural values and beings. Perhaps a blastocyst is really a person in some sense that deserves moral and legal respect or protection. Science cannot answer such questions; they require nonscientific methods such as introspection, intuition, or faith. Therefore, we come here to epistemological debates. Scientists acting in their roles as scientists rely on empirical observation and rational explanation as the way to know about the world. Science may draw on, but as science does not rely on, appeal to introspection, intuition, or faith. Religion relies precisely on these methods.

We now have two sets of debates: metaphysical debates about the nature of what exists in the world, and epistemological debates about how we should go about knowing about it. These debates have

become more obvious and contested in different ways with human embryo research. Scientists have their views about what is right and good, but they accept the need for social and political resolution of the moral issues. Some of those moral imperatives, and even some religious injunctions call for carrying out scientific research. For example, traditional Jewish values place highest priority on saving lives even if that means using stem cells from early embryonic stages that are not considered persons in Jewish law. Meanwhile, extreme embryo protectionists accept that there may be scientific needs but feel that their own moral considerations should trump when there is conflict.

Both metaphysical and epistemological differences are also at issue in debates about evolution. "The controversy" has been set up such that the extremes of antireligion scientists and antievolution creationists have staked their positions in strong terms and in opposite corners. They have allowed public discussion to develop as if this were a matter of science versus religion. Yet we are back to the need to tease apart the different threads of what is really a tangle of debates.

UNTANGLING ISSUES

For those who see the world in terms of integrated holistic worldviews, different threads of commitment and belief are entangled. Probably inevitably, we each hold some set of entangled views, and doing so is convenient. It keeps us from having to think about every single episode that comes along and decide our view on that particular case. Yet some individuals and groups find it useful to entangle even more threads and hold them tightly together. We each make decisions about which threads to accept as given, and the question then is how many we hold true in this way and what we do when one is questioned.

Science requires questioning, discovery, and skepticism, leading to interpretations and reinterpretations in the light of new knowledge. Many religions allow questioning and discovery as well, of

course. Yet some, including fundamentalist antinaturalist religious views, do not. I would like to believe that most people would embrace scientific questioning and discovery about the natural world and would appeal to other compatible views about moral and metaphysical views beyond what science can provide only where necessary to fill the gaps, if only they were given that choice. We must work to give them that choice, beginning with honest worldview untangling. There are many different ways to untangle the threads, of course, but for our purposes here, we can focus on five sets of issues that cut across metaphysical and epistemological issues.

Evolution versus Creation (as Theories Explaining How the Organic World Has Come to Be as It Is)

Both science and religion ask the question, "How has the organic world come to be as it is?" One Intelligent Design debate, then, is at root epistemological: Should we address that question with the scientific methods of empiricism and interpretation, or do we appeal to faith and introspection? Historically all versions of "creation" stories have invoked a creator outside the material world and rely on other than scientific authority for such claims. Thus, we have questions about how far science can take us and what we need to fill the gaps that remain.

Some religious extremists prefer to see a conflict between science and religion, and they assert that we can know about the world only through religious revelations. Similarly, some scientists prefer to see conflict when they go beyond science to insist that only science can give us any sort of knowledge. Scientists acting scientifically cannot establish that there was no creator, since that claim lies outside the bounds of scientific testability. We can say that there is no—and cannot, given the foundations of scientific method, be any—scientific evidence of any supernatural creator. But that, of course, will hardly be compelling for the religiously inclined who find their evidence elsewhere.

Those who wish to do so can appeal to other values and methods, including metaphysical views from religion, to assert the existence

of a creator. Others will prefer to invoke values such as parsimony or metaphysical materialism to argue against the existence of any supernatural being or forces that we cannot experience through material senses. These differences are often laid out as religion versus atheism (or antitheism), and sociologically the debates often take that form. Yet logically, what we have is a difference of theism and nontheism. That is, from the scientific, naturalist methods and knowledge, we cannot know that there is no deity. Whereas atheists actively deny the existence of a god, nontheists hold that the question of whether or not there is a god is irrelevant and unknowable. We can only know that the category makes no sense within science and that it requires other values and views to invoke such a nonnatural thing.

Evolutionism (or Scientism) versus Creationism (as a Worldview)

Let us pursue further these distinctions about what can be known within science and what requires additional claims external to science. Scientists understand that only science can give reliable, justified *scientific* knowledge and evolutionism is a special case where evolution provides the knowledge, in particular about how species arise and what makes the organic world as it is. Extreme proponents of evolutionism, including notably Dennett and Dawkins, profess that they know that evolution and science are all there is. As Ruse has discussed clearly, such views are unwarranted and evolutionism taken too far becomes "belief" in the sense of unsupported doctrine. To be clear: I am not claiming that evolutionary science is belief in this sense; it is not. Rather, evolutionism as a philosophical position goes beyond science. To reiterate: science itself gives us no way of knowing that there is nothing beyond science and the natural world.

It has been in the interest of some extreme evolutionists to attack all creationists for their lack of scientific reasoning and to see them as denying any science, which is not fair. There are many people who believe in some sort of limited first origins type of creation (indeed, I suspect nearly all of them except the maniacal) who perfectly well

accept that there is a natural world and even that science will give us the best knowledge about most of it. But they deny that science can give us everything we need to understand how any species arose (for those who deny evolution altogether), how humans arose (for those who envision a special creation for man), or how life or the universe began in the first place (for those who allow a naturalistic role for evolution but not for first origins).

Conversely, it has been in the interest of creationists to attack evolutionists for rejection of a creator and to imply that this leads down a slippery slope. The strongest forms of this completely unjustified attack claim that because evolutionists deny that the human species was specially created, therefore they have no moral values including no valuing of human life. This is absurd, of course, since most evolutionists perfectly well accept that there are values and social interactions that go beyond evolution and even that human life has value. Rather, the value and the process of evaluation lie outside science and its methods.

Evolutionary biologists claim neither that evolution provides all answers to everything, nor that science can answer everything. Nor is the acceptance of values outside of science *per se* a problem for the doing of science. We expect a diversity of ideas in a pluralistic society. Science gives us the best way of knowing about the natural and organic world, but other values and ways of knowing may also have a role—and this is important—only insofar as they do not contradict the claims of the sciences about the natural world.

With respect to our views of embryos, most citizens fall somewhere between the extreme that says that the fertilized egg cell is a person deserving of full legal protections and that therefore no research should be allowed on cells derived from it, even if they would be thrown away otherwise, and the extreme that says that researchers should be allowed to do anything they want at any time. Most citizens are also experienced enough to realize that extreme hopeful hype (stem cell research will lead to solutions for all medical problems you can imagine) and fear-mongering (stem cell research

will turn us into uncaring Nazis) are both unwarranted extreme positions.

There is, in other words, a great range of possible ways to find compatibility of different epistemological and metaphysical views and values. Science and evolution, creation and values: all can reside together as long as we are fair-minded, tolerant, and recognize the boundaries and limits. This is not the place for further detailed discussion of demarcation criteria between science and religion, but rather to note that comfortable compatibilism can occur in diverse ways.

Process and Change versus Fixity and Given

Another debate intersects the others and concerns the extent to which we see properties of change and process rather than fixity and stability in the world. With evolution, it is obvious that those accepting evolutionary explanations for how the natural world came to be this way accept that there has been change. Creationists accept a range of types of change, but extreme conservative creationists want much to be given and fixed. They claim that a creator must have created, that the world goes on without much change, and that they know what is true and right even if others—indeed even if most others—disagree. This shows the extent to which some are uncomfortable with the idea of any change. The desire to control change feeds back into desire for a solid and predictable interpretation of the world, which does not work well with the continual inquiry and discovery of the scientific approach.

The differences play out in interesting ways in the embryonic stem cell debates. Here, some scientists themselves have appeared to embrace the stability perspective, and this has perhaps reinforced social interpretations of what an embryo is. Geneticists, in promoting their program by (over)emphasizing the importance of genes in causing effects, have created a misimpression. The public has a strong sense that genes cause development, fairly directly, so that "genes are us." This leads to a sort of preformationist thinking, as I

explain in more detail in *Whose View of Life?*, with the impression that once an individual organism has its full complement of genes lined up along chromosomes, it is effectively determined and just grows and plays out the program already encoded genetically. Unfortunately, this geneticism also feeds the sense that the organism is fixed and that it is, in fact, already effectively the person it might become later. Such thinking is unfortunate in that it unintentionally reinforces a religious and social interpretation that lies outside science and holds that the individual's life begins at conception (typically meaning fertilization).

This is true in only the most limited sense. There are good reasons that a wide range of traditional views have seen life as beginning only with "quickening," typically taken as occurring at forty days. In fact, as we know now, genes are useless unless and until they are expressed during development. The first cell division process begins after fertilization, but gene expression, growth, differentiation, and other features of living organisms come only later. And we know that details of differentiation and morphogenesis are highly dependent on the context and the environment. Indeed, embryonic stem cell research has attracted such attention precisely because the differentiation process depends so much on context, the particular culture medium, and environmental stimuli, and because it allows such plasticity and responsiveness. It is therefore unfortunate that we are left with an excitement about process and change, but a background of mushy assumptions about preformation and fixity.

Secularism/Rationalism versus Religion/Spiritualism

As mentioned above, at least part of what is at issue is a debate about epistemology. What are the legitimate ways by which we come to know something? Do we achieve knowledge through reason, logic, and science, or through faith, introspection, and intuition? Once again, of course, these are not extreme polarities with no positions between. Many people, and again perhaps the vast majority, hold to some version of rationalism and naturalism with an empha-

sis on secularism in most aspects of their lives. Traffic directions, cooking, and other domains function by natural and social laws that are separate from religion. Airplanes fly, and we understand how they fly through science and engineering, and not through prayer, no matter how many passengers may engage in prayer while flying. Yes, for those who choose to do so, they may consistently accept scientific epistemology and yet also embrace some aspects of religion, even accepting that some types of knowledge may be grasped through faith—as long as faith does not deny the role of reason and science is accepted as the best approach for understanding the natural world. But no, it is not acceptable, given what we know about social norms, to deny that any reason exists and that everything is solely spiritual. We have bodies that do work at least in large part like machines, and nearly everybody in the developed world understands and takes care of those bodies based on scientifically driven material medical principles.

Stephen Jay Gould called science and religion "nonoverlapping magisteria" and they are that to some extent. Science and religion need not overlap. Yet, as Ruse and a number of historians of science have pointed out persuasively, they may. They may compete for authority, control, and power, but need not even if there are overlaps.[5]

Our social and legal norms help decide where the boundaries lie. Within the law, the U.S. Constitution makes one thing very clear. The First Amendment Establishment Clause has been interpreted as prohibiting public institutions from establishing religion in general or any one religion in particular. ("Congress shall make no law respecting an establishment of religion.") This has been taken as requiring that public education must remain secular and may not promote religion, and that directly affects what may be taught in schools.

What to Teach versus What to Require Being Learned

In public education, we have two different issues that go beyond basic views about epistemology and metaphysics and morals to the legal: the nonestablishment of religion, and also the impact of a

shift from an emphasis on what teachers will teach to an emphasis on tests, focusing on what students should be required to learn. From the beginnings of public education in what became the United States at the Boston Latin School around 1645, public education has been taken to be a local matter. States hold authority to direct, and school districts to oversee and implement, curricular and instructional decisions. Most of these decisions have focused on textbook selection and on what to teach or not teach. It has always been easy to decide to teach reading, writing, arithmetic, science, along with areas such as history and social studies. Most issues have been about how much to teach and whether teachers are prepared to do the teaching and students to learn at the appropriate level. Two areas have often provoked considerable controversy, however: sex education and whether to teach evolution. Traditionally, these debates have played out locally, with periodic bursts of activity at the state and recently at the national level, ironically led by President George W. Bush, who on other issues has supported states' rights.

For example, Tennessee passed a state law in 1925, labeled the Butler Act, "prohibiting the teaching of the Evolution Theory in all the Universities, Normals and all other public schools of Tennessee, which are supported in whole or in part by the public school funds of the State, and to provide penalties for the violations thereof." Dayton teacher John T. Scopes challenged the law, which led to the highly publicized Scopes trial. Scopes lost, despite the rhetorical successes on his side, and the trial brought wide public awareness of debates about evolution and creation in this law that prohibited the teaching of evolution in Tennessee schools.

Only in 1968, when the Supreme Court agreed to hear *Epperson v. Arkansas* and ruled that laws prohibiting the teaching of evolution amount to an attempt to establish religion: only then was evolution taught in Tennessee's public school biology classes. As a student who graduated from high school in Oak Ridge, Tennessee, in 1968, I read Darwin's *Origin* in English class. Even in this highly educated, science-oriented high school, teachers were not allowed to adopt textbooks or teach evolution in biology classes until the courts

forced them to do so, but our English teacher thought we should know about the ideas. Yet even after *Epperson* forced the states to allow the teaching of evolution, in 1973, Tennessee passed a law requiring that evolution be labeled "a theory" and that equal space be given in textbooks to "other theories," explicitly including the Genesis account of creation. Other state actions and court rulings have further defined the discussion about what is allowed.

These decisions have focused on what teachers are allowed to teach and what school districts are allowed to include. In the late 1990s, the discussion shifted. Yes, there are still discussions about what sex education or how much diversity study or which history, for example, will be allowed in classrooms, as well as whether and how to teach evolution. But instead of debates about what to allow, the discussion is now predominantly about what to require.

This changed with the growing national demand for "standards." This demand converged from a number of quite divergent directions. A frustration about the declining literacy and success rates among U.S. high school graduates raised the call for improved standards across the boards. In the sciences, leading scientific organizations such as the American Association for the Advancement of Science developed Project 2061 to guide science education, and the National Research Council developed its *National Science Education Standards*.

The impetus came from a general agreement that science education in this country was failing, and a coalition emerged among those concerned mainly about the low educational standards and those concerned about the declining American workforce. In addition, the U.S. Congress under Newt Gingrich's leadership of the House of Representatives both embraced science as a potential salvation and deplored the slide into poor quality. Republican leadership raised the call for standards—in science education, in education generally, in government agencies (with the Government Performance and Results Act of 1993). As the Government Accounting Office explains it, the Act "seeks to shift the focus of government decision-making and accountability away from a preoccupation

with the activities that are undertaken—such as grants dispensed or inspections made—to a focus on the results of those activities, such as real gains in employability, safety, responsiveness, or program quality. Under the Act, agencies are to develop multiyear strategic plans, annual performance plans, and annual performance reports."[6]

This emphasis on plans and reports led educators to tests. How better to assess performance, state after state decided, than to develop tests? But what would be tested? Learning outcomes, they decided, based on standards. State after state began developing standards, outcomes, and tests. The No Child Left Behind Act signed into law in 2002 reinforced this approach. The Act emphasizes local freedom to develop standards and teaching plans according to local needs, but only if there are standards and tests and results that can be measured and compared. This is not the place to discuss the reasons for and against this approach, but rather to note that the decision has had effects. Now each teacher, each school, each school district, and each state has to make explicit decisions about what to teach and what to test.

This emphasis means, of course, that every state has to decide whether it will teach evolution and whether and how students will be tested on that teaching. The state of Arizona illustrates the kinds of local political debates that go on to determine what will be presented as good science in the schools and in the tests. In 1997, in the flush of enthusiasm about developing standards and forcing accountability, a committee was asked to develop a set of standards and present them to the Board of Education. They developed a draft, borrowing heavily as nearly all states did from the National Research Council's *Standards*. Alert school teachers discovered that the draft did not follow the NRC's standards completely, however, and had carefully omitted any mention of evolution.

The Board of Education appointed a review committee to assess the science standards and present a revised version. Each member of the Board appointed one member to the committee, with the result that the committee was divided as to whether to include evolution or

not. I served on the committee at the request of Arizona State University's president, as did a colleague of mine, Steve Rissing, who was appointed by the Superintendent of Public Instruction and who has since been a leading advocate for teaching evolution in the state of Ohio.

Steve and I found deeply entrenched creationists on the committee. They realized that they could not block the teaching of evolution completely, since there was such strong support for it. So, they took one of the common approaches of insisting that we teach "the controversy." In 1997, the popular language was that we must "teach the evidence for and against" evolution. This approach had worked in some states, and it continues to be the main attempt to leverage some form of creationism into the curriculum and into the standards.

These creationists argued that no honest scientist can oppose teaching evidence. Surely science is about evidence, and about learning to weigh evidence for and against theories. Therefore, how can anyone object. Indeed, President Bush took this approach in his remarks in August 2005, commenting on the *Dover* case. He said of evolution and Intelligent Design that "both sides ought to be properly taught . . . so people can understand what the debate is about." And further, that "part of education is to expose people to different schools of thought . . . You're asking me whether or not people ought to be exposed to different ideas, and the answer is yes."[7]

Surely we can all agree that teaching about evidence is good. Evidence for and against theories. What we did in Arizona—and this approach has held through one major and several minor challenges—was to agree. We accepted the call to discuss evidence for and against—but for and against all theories, not just evolution. We took the "evidence for and against" clause out of its direct connection to "evolution," in other words, and made it a standard itself so that students have to learn about the nature of science and its use of evidence as applied to any ideas in science. This follows the NRC *National Science Education Standards* and the AAAS *Benchmarks for Science Literacy*, each of which emphasizes the nature and history of science.

Every student should learn about the methods and processes of doing science, including how to use evidence in assessing theories. Teachers will teach about evolution, natural selection, change over long periods of time, and the other core ideas of evolution. They will teach about what a scientific theory is—whether gravitational theory, molecular theory, or evolutionary theory. And they will learn about how scientists test theories and accumulate evidence to make them stronger, and about how accumulated evidence makes some theories so strong that we can take them as extremely well established and as the basis for predictions. We can treat them, in effect, as "fact." This is what we do with evolutionary theory. Now students know that evolution, like other theories of science, is not "just a theory," but that it has the tremendous power of a well-established scientific theory that is based on considerable accumulated evidence, is tested rigorously, and offers testable predictions. Evolutionary science has tremendous accumulations of evidence for and no scientific evidence against the science. The purported "evidence against" comes from outside science and does not stand up to scientific test. It is very useful to understand that such a "theory" holds the highest and most powerful status in science, alongside the theories of gravitation, a sun-centered universe, or genetic inheritance.

But, of course, this idea of "the evidence" is not what creationists want at all, even though in Arizona we managed to convince enough of them so that evolution and its central tenets did end up in the science standards. In fact, extreme evangelical creationists want to determine by themselves what will count as evidence against evolution. In Arizona, they wanted to dictate which textbook would count, and that is true in many states. A very few textbooks would be acceptable, and not coincidentally the authors of those textbooks have often actively campaigned to have their books adopted. This extremely significant profit motive cannot be ignored as motivator in the argument for "alternative" educational materials, though it is obviously only part of the story.

What is at heart for the true believers is just that—true belief. They believe that they are struggling for the hearts and souls of

American children. Science educators on the other hand, believe that science education should be a matter of struggling for the minds of those children. This is one point of conflict, and it takes us back to the sets of different controversies involved. For many creationists, the debate is about worldviews and values, and not really about science at all. They want to establish their values, their views, and their beliefs. And that brings us to the Establishment Clause and the *Dover* ruling.

DOVER

For Judge Jones, it is clear what schools should be allowed to teach in science classes: science and only science. Intelligent Design is not science and evolution is, he explained very clearly in his ruling in *Kitzmiller v. Dover Area School District*, in a ruling released December 20, 2005. The ruling seemed to many commentators like a lovely Christmas holiday gift to those advocating the fair and open teaching of evolution.

To review key features of the case: on October 18, 2004, the Dover school district's board had voted that "students will be made aware of gaps/problems in Darwin's theory and of other theories of evolution including, but not limited to, intelligent design. Note: Origin of Life is not taught." The school district then announced that teachers would be required to read to ninth-grade students the following statement:

> The Pennsylvania Academic Standards require students to learn about Darwin's Theory of Evolution and eventually to take a standardized test of which evolution is a part.
>
> Because Darwin's Theory is a theory, it continues to be tested as new evidence is discovered. The Theory is not a fact. Gaps in the Theory exist for which there is no evidence. A theory is defined as a well-tested explanation that unifies a broad range of observations.
>
> Intelligent Design is an explanation of the origin of life that differs from Darwin's view. The reference book, *Of Pandas and*

People, is available for students who might be interested in gaining an understanding of what Intelligent Design actually involves.

With respect to any theory, students are encouraged to keep an open mind. The school leaves the discussion of the Origins of Life to individual students and their families. As a Standards-driven district, class instruction focuses upon preparing students to achieve proficiency on Standards-based assessments.[8]

Tammy Kitzmiller and other parents filed suit challenging the constitutionality of the statement. They felt that this statement was a promotion of the philosophy of Intelligent Design in particular and that it amounted to an attempt to establish a religion in public schools. Judge Jones concluded that "for the reasons that follow, we hold that the ID Policy is unconstitutional pursuant to the Establishment Clause of the First Amendment of the United States Constitution and Art. I, § 3 of the Pennsylvania Constitution."[9]

Judge Jones's ruling very clearly untangles distinct issues and is helpful in promoting public understanding of what is involved in the multiple and tangled debates.

- First, there are claims about what should count as science: the ID proponents arguing that ID is science, and opponents arguing that it is not. Jones notes that this understandably depends on clear definitions of what science is and what authorities shall determine this.
- Therefore, the first question involves a second set of claims about what science is and who decides: with clearly articulated definitions and criteria laid out. Jones describes in detail the testimony of philosophers of science such as Robert Pennock in laying out the boundary criteria in clear, reliable, and verifiable ways. And it is clear that the scientific community of experts in a particular field should be the arbiters.
- Third are claims about whether ID is an attempt to establish religion in the schools: ID proponents arguing no, and

opponents arguing yes. This requires an understanding of the nature and realm of religion.

- Therefore, this third issue requires an evaluation of what counts as a religion and on what authority and evidence. Jones relied on the history of debates about evolution and creationism and what he saw as a compelling argument that ID is a continuation of previous antievolution creationist traditions.
- Finally, there are also discussions of what students should be allowed to learn and what they should be expected to learn, enforced through standards and tests.

This latter point was especially important in leading Jones to his ruling about this particular case. The second paragraph of the statement that the school district required to be read states that "Darwin's Theory is a theory . . . The Theory is not a fact." Judge Jones noted that in thus singling out evolution from the rest of science, it

> informs students that evolution, unlike anything else that they are learning, is "just a theory," which plays on the "colloquial or popular understanding of the term ['theory'] and suggest[ing] to the informed, reasonable observer that evolution is only a highly questionable 'opinion' or a 'hunch.'"

This is a deliberate attempt to mislead, Jones argued, and the continuation of the statement pointing to gaps fails to note that there are gaps in other scientific theories as well. It is the singling out of evolution that ultimately caused Jones to rule that ID is not science and that it has no place in science classes in public schools.[10]

Jones rejected the ID proponents' claim that what they want is simply to teach "the controversy." There is no controversy, Jones concluded. Or rather there is no controversy within science. There is no controversy that belongs in public education. There is no controversy about science versus religion as "the" way of knowing about the natural world. He vigorously rejected the claim by ID proponents that their statement was not an attempt to teach ID but that they

were only "making students aware of it." As Jones noted, "In fact, one consistency among Dover School Board members' testimony, which was marked by selective memories and outright lies under oath, as will be discussed in more detail below, is that they did not think they needed to be knowledgeable about ID because it was not being taught to the students. We disagree."[11]

Jones opted for a version of compatibilism, even if the ID advocates did not. He noted that "after a searching review of the record and applicable caselaw, we find that while ID arguments may be true, a proposition on which the Court takes no position, ID is not science." ID fails on three counts: it invokes supernatural causation, claims irreducible complexity, and offers attacks on evolution (like Michael Behe's) that have been rejected by the scientific community. ID is not a science. It may be true as religion, but that is not at issue.[12]

In his conclusion, Judge Jones makes the ID claims very clear and provides a strong argument for holding evolution and religion as compatible. "Both Defendants and many of the leading proponents of ID make a bedrock assumption which is utterly false. Their presupposition is that evolutionary theory is antithetical to a belief in the existence of a supreme being and to religion in general. Repeatedly in this trial, Plaintiffs' scientific experts testified that the theory of evolution represents good science, is overwhelmingly accepted by the scientific community, and that it in no way conflicts with, nor does it deny, the existence of a divine creator."[13]

Judge Jones's wise and well-grounded ruling is extremely important. It shows that both those who would seek to establish ID or other forms of religious creationism as science and those who would seek to establish that scientism leads to a rejection of a divine creator are unjustified in their beliefs. Evolution is not opposed to religion, just as embryo science is not opposed to morality. There is room for both, and there is room for social and political decisions about what form of compatibility we will embrace. What is clear is that the result cannot involve rejecting the study of evolution. Unlike the challenges with human embryonic stem cell research, where the

very doing of the science raises special moral questions that scientists themselves recognize and that call for social and political resolutions, there are no such challenges with evolution. We need to study evolution, and not doing so has consequences.

WHY IT MATTERS: BUGS AND DRUGS

For many reasons, studying evolution is important, and indeed essential for a civilized society. I will focus just briefly on only two: study of human-host pathogen interactions, and biodiversity.

Take avian flu, or the H5N1 mutation of the virus. News reports track the progress of this virus around the world, and the Center for Disease Control is carefully tracking when it will arrive in the United States and whether and when it will jump from birds to humans. Many viruses have made this jump. And while only a few human cases of H5N1 infection have been reported yet, the virus is extremely contagious and it is very virulent in birds and humans, with a high death rate. Authorities around the world are on alert for the virus and its effects.

We would have no epidemiologically useful understanding of the virus without an understanding of evolution. Nor of HIV, nor any of the many other pathogens that affect animals and humans. Viruses and bacteria mutate. We understand mutation through genetics. But populations of viruses, and the particular strain of viruses that dominate, are the result of population change, natural selection, and evolution. Every year, the CDC and other health organizations around the world make their best guesses about the way evolution will work to develop the best possible influenza vaccines.

The bubonic plague pandemics of the fourteenth century, HIV epidemics, and other diseases that affect humans have evolved, and sometimes they evolve quickly. As a society, we use our science and technology to develop vaccines and antibiotics. Sometimes, however, the pathogens evolve faster than we are able to keep up. Some strains of tuberculosis pathogens have developed drug resistance, and some even multiple drug resistances. The only way to under-

stand and have any hope of keeping ahead of such developments is through an understanding of population changes and evolution. A society that rejects understanding of evolution is one that cannot understand the behavior of the bugs that affect us, nor the drugs that will serve to treat our diseases. Nor can we understand bugs at a different level. To understand ants, termites, or bees—all social insects, with highly complex societies adapted to diverse environments—we need evolution. And only with understanding of evolution can we borrow lessons from these social communities.

A second important area requiring understanding of evolution is biodiversity. We seem to be losing numbers of species, as well as numbers of individuals within many species, at a drastically increasing rate. This matters for both instrumental and aesthetic reasons. We use many of the world's plants and animals as resources—for food and medicines. Furthermore, most human societies have valued animals and plants for aesthetic reasons. A green and leafy environment is more welcoming than a barren one. A land of milk and honey is more attractive than an arid barren land of winds and sand. Furthermore and most importantly, ecologists are demonstrating that we humans cannot survive without the support of a complex interactive ecosystem full of other life forms.

Therefore, we need understanding of evolution. We need the science, and there is also room to allow some versions of religion. Not narrow, evangelical, science-bashing religion, but open-minded, tolerant, and well-behaved religion. The sort of religion that I hope most fair-minded intelligent Americans who are inclined to embrace any form of religion will hold. Once we untangle the bank of issues, there is grandeur in this view.