Intelligent Design Has No Place in the Science Curriculum

By Harold Morowitz, Robert Hazen and James Trefil

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Scientists who teach evolution sometimes feel as if they are trapped in an old horror film - the kind where the monster is killed repeatedly, only to come to life in a nastier form each time. Since the Scopes trial in 1925, the battle between scientists who want to teach mainstream biology in American public schools, and creationists who want to promulgate a more religious view, has gone through several cycles.

In McLean v. Arkansas Board of Education in 1982, a federal court ruled that the introduction of creationism into public-school curricula constituted the establishment of religion, and hence was expressly forbidden by the First Amendment. That decision dealt a serious (though by no means fatal) blow to old-line creationism and its close cousin, so-called creation science. But another variant of creationism, so-called intelligent design, has cropped up. At least 19 states are now debating its use in public education, and President Bush commented in August that he thought both evolution and intelligent design "ought to be properly taught."

Many people fail to understand the subtle but important differences between the new and old forms of creationism, and the different debates those approaches engender. Like the French generals who used tactics from World War I to face the Nazis in 1939, some educators seem intent on fighting the last war.

A word about the authors of this essay: Although our areas of expertise differ, all of us have investigated aspects of life's origin and evolution. In addition, our political views span the spectrum from liberal Democrat to conservative Republican. Thus the essay does not represent any particular ideological or disciplinary viewpoint. We are united in our concern that the science curriculum, from kindergarten through university, should reflect the best and most up-to-date scholarship.

Consider, then, several different theories of life's origin and evolution. The main theories are those of miraculous creation and of sequential origins. Within the theories of sequential origins are the theories of intelligent design and of emergent complexity, and the latter can in turn be divided into the theories of frozen accident and of deterministic origins. The debate surrounding each pair focuses on a different aspect of the nature of science.

Miraculous creation versus sequential origins. Was the origin of life a miracle, or did it conform to natural law - and how can we tell? Many different versions of the doctrine of miraculous creation exist, but the one that is most at odds with modern science is called "young Earth creationism" and is based on a literal reading of the Bible. According to the supporters of that theory, our planet and its life-forms were created more or less in their present forms in a miraculous act about 10,000 years ago.

Young Earth creationism is in direct conflict with scientific measurements of the age of rocks, the thickness of polar ice sheets, the expansion of the universe, and numerous other indicators of our planet's great antiquity.

One unusual solution to that disparity was proposed in a book by Philip Gosse, called Omphalos, which was published two years before Darwin's On the Origin of Species. The word "omphalos" means navel in Greek, and Gosse argued that Adam was created with a navel, even though he had never been inside a womb. From that insight has flowed the so-called doctrine of created antiquity (Gosse actually called it Pre-Chronism), which states that although Earth was created 10,000 years ago, it was created to look as if it were much older. Are some stars more than 10,000 light-years away? The universe was created with light from those stars already on its way to Earth. And what about those apparently ancient rocks? The universe was created with just the right mixtures of potassium-40 and argon to make the rocks appear much older than they really are.

It is impossible to conceive of any experiment or observation that could prove the doctrine of created antiquity wrong. Any result, no matter what it was, could be explained by saying "the universe was just created that way."

In fact, that property of young Earth creationism proved to be its Achilles' heel. Every scientific theory must be testable by observation or experiment - or it cannot be considered science. In principle, it must be possible to imagine outcomes that would prove the theory wrong. In the words of Karl Popper, scientific theories must be falsifiable, even if they are not false. Popper said that a theory that cannot be overturned by experimental data is not a part of experimental science.

Created antiquity is not falsifiable. The teaching of young Earth creationism, along with any other doctrine based on a miraculous creation of life, was prohibited in public schools not because the theory was proved wrong but because it simply is not science. It is, as the court in McLean v. Arkansas Board of Education recognized, a religious doctrine, untestable by the techniques of science.

Once we discard the theories of miraculous creation, we are left with the theories of sequential origins.

Intelligent design versus emergent complexity. The theory of intelligent design, or ID, is a theory of sequential origins, but it is also the latest attack on the idea that the origin and evolution of life follow natural laws. Like created antiquity, ID has a long intellectual pedigree. The English philosopher William Paley first espoused it in 1802, arguing that if you found a watch in a field, you would conclude that it had been designed by some intelligence rather than assembled by chance. In the same way, the argument goes, the intricate universe in which we live reflects the mind of an intelligent maker.

The modern theory of intelligent design is more sophisticated than Paley's argument, although it derives from much the same kind of reasoning. It is anchored in a concept called "irreducible complexity" - the idea that organisms possess many complicated structures, which are essential to the organism's survival but which are useless unless all the structures are present. The chance of Darwinian evolution's producing so many such structures and of their existing simultaneously, according to the theory, is so small that they must have been produced by an intelligent designer.

Intelligent design challenges the conventional wisdom in origin-of-life research that life is a prime example of so-called emergent complexity. All around us are complex systems that arise when energy flows through a collection of particles, like living cells or grains of sand. Ant colonies, slime molds, sand dunes, spiral galaxies, traffic jams, and human consciousness are examples of such systems. Although scientists have yet to produce a living system in the laboratory, most origin-of-life researchers are optimistic that one day we will be able to do so, or at least to understand how life first emerged from inorganic materials.

The supporters of intelligent design resort to the same kind of argument that creationists have used for decades, identifying some biological structure and claiming that it is irreducibly complex. Then supporters of emergent complexity have to analyze that structure and show that its complexity arises naturally. For example, 20 years ago, the predecessors of ID advocates pointed to the modern whale as an example of what would be called irreducible complexity today (that term wasn't used then). The whale, they argued, is a form so specialized that it could not possibly have been produced by Darwinian evolution.

Alan Haywood, author of Creation and Evolution, put it this way: "Darwinists rarely mention the whale because it presents them with one of their most insoluble problems. They believe that somehow a whale must have evolved from an ordinary land-dwelling animal, which took to the sea and lost its legs. ... A land mammal that was in the process of becoming a whale would fall between two stools - it would not be fitted for life on land or at sea, and would have no hope for survival."

The power of science is that, faced with such a challenge, one can test the relevant theory. The theory of evolution predicts that whales with atrophied hind legs must have once swum in the seas. If Darwin is correct, then those whales' fossils must lie buried somewhere. Furthermore, those strange creatures must have arisen during a relatively narrow interval of geological time, after the evolution of the earliest known marine mammals (about 60 million years ago) and before the appearance of the streamlined whales of the present era (which show up in the fossil record during the past 30 million years). Armed with those conclusions, paleontologists searched shallow marine formations from 35 million to 55 million years in age. Sure enough, in the past decade the scientists have excavated dozens of those "missing links" in the development of the whale - curious creatures that sport combinations of anatomical features characteristic of land and sea mammals.

But there's always another challenge to evolution, always another supposed example of irreducible complexity. At the present time the poster child of intelligent design is the flagellum of a bacterium. That complex structure in bacterial walls features a corkscrew-shaped fiber that rotates, propelling the bacterium through the water. Obviously, a completely functioning flagellum is very useful, but it is also obvious that all its parts have to be present for it to function. A nonmoving corkscrew, for example, would be useless and would confer no evolutionary advantage on its own. Roughly 50 molecules are involved in constructing the flagellum, so the probability of all the parts' coming together by chance seems infinitesimally small.

However, that intelligent-design argument contains a hidden assumption: that all parts of a complex structure must have had the same function throughout the history of the development of the organism. In fact, it is quite common for structures to have one function at one time and be adapted for quite another use later on. A land animal's legs become a whale's flippers. An insect may develop bumps on the side of its body to help it get rid of internal heat, but when the bumps get big enough, they may help the insect glide or fly, thus opening up an entirely new ecological niche for exploitation. That process is so common that evolutionary scientists have given it a name: exaptation.

No evolutionary theorist would suggest that something as complex as the flagellum appeared ab initio. Instead, it was assembled from parts that had developed for other uses. For example, some molecules produce energy by rotating, a normal

procedure within cells. Other molecules have a shape that makes them ideal for moving materials across cell membranes. The flagellum's building blocks include both types of molecules. Instead of being assembled from scratch, then, the flagellum is put together from a stock of already existing parts, each of which evolved to carry out a completely different task. The flagellum may be complicated, but it is not irreducibly complex.

An important distinction between the theories of intelligent design and miraculous creation is that the former makes predictions that can be tested. The problem with ID, at least so far, is that when statements like the one claiming irreducible complexity for the flagellum are put to the test, they turn out to be wrong.

That distinction means that we should use different methods to counter intelligent design than those that defeated young Earth creationism. The more thoughtful advocates of intelligent design accept many of the tenets of Darwinism - the idea that living things have changed over time, for example. Although the motive of some ID proponents may be to re-introduce God into the debate about the origin of life, their arguments can be met with scientific, not legal, rebuttals. That is good news: They are playing on our field.

Frozen accident versus deterministic origins. The last pair of theories are both subsets of emergent complexity, and both fall within the scientific mainstream; the debate here is about whether life had to develop the way it did, or whether it could have turned out differently. A number of distinguished scientists see the development of life on our planet as a series of accidental, perhaps improbable, events that became locked into the structures of living things - what have been termed "frozen accidents." In the words of the most eloquent advocate for that point of view, the late Stephen Jay Gould, if you played the tape again, you would get a different set of accidents, and hence a different outcome. Therefore life may be rare in the universe, and the way it began and evolved on Earth may be unique.

Other scientists see life's chemical origin and many of its subsequent evolutionary steps as inevitable - a cosmic imperative. Indeed, much modern research on the origin of life is devoted to showing precisely how living things arose from inanimate matter through the action of the ordinary laws of chemistry and physics. That more deterministic view of life's origin and evolution means scientists are more likely to eventually understand the details of life's emergence, and it includes the testable prediction that similar life-forms exist on many other planets throughout the universe.

It seems to us that the frozen-accident theory of life's origin is at best unsatisfying, and may be unworthy of the scientific way of approaching the world. To say that a natural process is random is, in effect, an act of surrender, something that should be done only as a last resort. If you read the frozen-accident literature carefully, you often get the feeling that what is really being said is: "My friends and I can't figure out why things happened this way, so it must have been random."

Another aspect of the frozen-accident school of thought has unfortunate consequences for the educational system. Random events are, by definition, not reproducible. That makes them disturbingly similar to the unknowable interventions posited by intelligent design. Is there really much difference between irreproducible random events and irreproducible acts of God? We should note, however, that proponents of the frozen-accident theory make no claims of divine intervention, while advocates of intelligent design do move on to theological arguments.

Although both the theories of frozen accident and deterministic origins have their supporters, virtually all scientists who work in the field believe that once living things appeared on our planet, the Darwinian process of natural selection guided their development. There is no disagreement on that point, although there is - and should be - vigorous debate on the details of the way natural selection has worked.

Shouldn't we just teach the debates? That is the rallying cry of intelligent-design advocates. Having learned their lesson in Arkansas in 1982, they no longer demand that schools teach the theory of miraculous creation. Instead they say that students should be told that legitimate alternatives to Darwinian evolution exist, and thus biology classes should include the theory of intelligent design.

That argument has an apparent fairness that is hard to resist, especially for academics who believe that, at least in the sciences, subjects should be approached with an open mind and critical thinking. But the idea of "teaching the debate" founders on two points.

First, there really is no debate in the mainstream literature. The vast majority of scientists who study the origin of life accept the idea of nonmiraculous origins without any reservations. Only creationists support the theory of intelligent design.

Second, American students, from kindergarten to university, spend far too little time as it is studying science. We shouldn't teach them about intelligent design for the same reason that we don't teach them that Earth is flat, or that flies are produced by spontaneous generation from rotting meat. It's bad science, and the curriculum has no room for bad science.

Our educational system produces citizens who are ill prepared to deal with a world increasingly dominated by scientific and technological advances. If we were to "teach the debate," what should we remove from the already inadequate curriculum to make room for an idea that has yet to meet even the most rudimentary scientific tests? Should we neglect the environment? Energy? Genetics? Most high-school biology courses devote a pitifully small amount of time to evolution, which is arguably the most important idea in the life sciences. Should we dilute that instruction even further?

The time to discuss altering the curriculum is when the theory of intelligent design reaches the point where it has serious arguments and data to put forward - to the point, in other words, where there is a significant debate among scientists.

Harold Morowitz, Robert Hazen, and James Trefil are, respectively, the Clarence J. Robinson Professors of biology and natural philosophy, earth sciences, and physics at George Mason University.