Darwin's Black Box: The Biochemical Challenge to Evolution. - book reviews

James A. Shapiro

VANNEVAR Bush had it right. Science is an "endless frontier." The sun replaces the earth at the center of the solar system. Microbiology supplants spontaneous generation. The concept of evolution makes it possible to invoke natural processes as the source of biological diversity. The indivisible atom yields to quantum physics, and relativity stretches Newtonian ideas of space and time out of all recognition.

Into this recurring intellectual revolution arrives Professor Michael J. Behe with the claim that random genetic change, natural selection, and gradual evolution must move aside in favor of intelligent design as an explanatory paradigm for biological adaptations. Is this book a serious critique of orthodox evolutionary theory? Or is it a misguided attempt to bring religion back into biology? Unfortunately, the answer to both questions is yes. Darwin's Black Box starts with the promise of taking us in useful new directions, but it ultimately disappoints the serious student of evolution by rehashing sterile disputes.

Professor Behe sets three goals in this book. The first is to introduce the lay reader to the fascinating world of biochemistry. Professor Behe views this science as uncovering the ultimate secrets of life. He calls cellular molecules "the bedrock of nature. Lower we cannot go . . . the cell -- Darwin's black box -- stands open." With the unqualified enthusiasm expressed by these statements, he guides the reader through the biochemical intricacies of several adaptive systems, ranging from the defensive artillery of the bombardier beetle to vision, blood clotting, and the immune response. His patient explanations reveal a conscientious teacher.

Professor Behe asserts that any credible evolutionary theory must account for biochemical inventions essential to survival. This assertion brings us to his second goal: to show that the Darwinian conceptual framework cannot explain cellular biochemistry. His basic argument is

that each useful adaptation involves a system displaying "irreducible complexity." Irreducibly complex systems comprise multiple interacting components which are not useful in isolation but which are all essential to the function of the system as a whole. A mousetrap serves as the pedagogic paradigm of an irreducibly complex device. Collectively, its pieces serve to entice and ensnare mice. Individually, none of them has any trapping ability. Moreover, a mousetrap deprived of any single component is completely defective. Thus, there is no way a mousetrap could evolve by accumulating separate pieces in a random process because there would be no function to select until all the pieces were present and properly organized to work together.

Compared with mousetraps, biochemical systems are incredibly intricate, as illustrated by the blood-clotting system. Clots are meshworks of one protein, fibrin, whose molecules rapidly link together into a fine web. To prevent inappropriate clotting, fibrin is made as an inactive precursor. Another protein, thrombin, cleaves the precursor to liberate fibrin when clotting is needed. As a fail-safe backup, thrombin itself is made as an inactive precursor whose activation in response to tissue damage requires a cascade of half a dozen proteins, sequentially cleaving and activating each other. There are also additional regulatory factors which either stimulate or inhibit the activation cascade. A schematic illustration of these biochemical interactions resembles the wiring diagram for an electronic circuit. This apparently baroque complexity is essential because, for circulation to be maintained, clotting must occur only at the right time and place. For Professor Behe, only intelligent design could explain such a complex, sophisticated, interdependent mechanism for sealing leaks in the circulatory system.

The argument that random variation and Darwinian gradualism may not be adequate to explain complex biological systems is hardly new. Behe quotes Darwin himself considering this possibility: "If it could be demonstrated that any complex organ existed which could not possibly have been formed by numerous, slight modifications, my theory would absolutely break down." Surely, then, contemporary Darwinists have answers to rebut critics like Professor Behe. In fact, there are no detailed Darwinian accounts for the evolution of any fundamental biochemical or cellular system, only a variety of wishful speculations. It is remarkable that Darwinism is accepted as a satisfactory explanation for such a vast subject -- evolution --with so little rigorous examination of how well its basic theses work in illuminating specific instances of biological adaptation or diversity.

Professor Behe's third goal is to herald the importance of the intelligent-design concept. Here he

seems to lose his footing. Curiously, he treats intelligent design as a novel discovery. "Unlike Darwinian evolution, the theory of intelligent design is new to modern science." However, until the last century (well into the era of "modern science"), most serious thinkers considered it self-evident that the remarkable capacities of living organisms, so superior to mechanical devices, must have an intelligent basis. Historically, then, the real issue is not the recent "discovery" of intelligent design in biology but rather why orthodox science currently denies what has seemed obvious for so long.

The second shortcoming of Darwin's Black Box is not pointing out explicitly how far modern biology has progressed in revealing the inherent intelligence of complex molecular and cellular systems. Professor Behe compares the blood-clotting cascade to a Rube Goldberg device, but it is actually a powerful real-time distributed computing system capable of evaluating the integrity of the entire circulatory apparatus and making appropriate clotting decisions. (The designers of Star Wars systems could do well to turn their attention to such biological defense networks as models for how to discriminate among potential dangers and make reliable decisions.) Contemporary cell and molecular biology focuses on the architecture and operation of "signal-transduction networks." These are cellular functions that process information about internal operations (e.g., DNA replication) and about the external environment to make decisions controlling growth, movement, and differentiation.

Professor Behe's most serious faux pas is suggesting that intelligent design may lie outside the domain of scientific investigation. "The dilemma is that while one side . . . is labeled intelligent design, the other side might be labeled God." The subtitle of the book (The Biochemical Challenge to Evolution) suggests that it attacks the idea of evolution, not just Darwinian theories of change. Even the scientific approach is questioned. In the third section of Darwin's Black Box, in a partially justified attack on groupthink in the scientific community, Professor Behe chides colleagues for asserting that scientists must strive for explanations exclusively in terms of natural phenomena. But his appeal to explanations beyond the realm of nature is premature. Darwinism and creationism are not the only conceivable intellectual frameworks for thinking about the evolution of biological adaptations and diversity. The pertinent scientific questions have not all been asked.

One can only guess that Professor Behe brings religion back into the evolutionary debate because he feels intelligence is somehow beyond nature. In this regard, there is an ironic convergence

with the neo-Darwinists who also want to exclude the possibility of intelligent action as part of the natural evolutionary process. Yet where does intelligence come from? Professor Behe cites human genetic engineering to bolster his argument that biochemical systems can be intelligently designed. Is human intelligence natural or supernatural? And what about animal intelligence in finding food, embryonic intelligence in overcoming mistakes and disruptions to produce healthy organisms, cellular intelligence to correct errors and imbalances in millions of coordinated biochemical reactions, and biochemical intelligence exhibited by systems like the blood-clotting cascade? Could these examples of intelligent action in nature relate to the appearance of intelligent biochemical systems in evolution?

Darwin's Black Box has the merit of showing us that evolution remains a mystery. Its fundamental driving forces have not been resolved either in detail or in principle. Where Darwin's Black Box undermines itself is in abandoning the effort to treat the question of intelligent design within science's own ongoing evolution. Professor Behe unfortunately expresses a static view of science. The accomplishments of molecular biology are presented as ultimate triumphs (". . . the bedrock of nature. Lower we cannot go . . .") rather than as one stage in a continuous process of questioning, discovery, and reconceptualization. Science repeatedly cycles back to basic issues. Biologists are debating anew whether life is purely mechanical. Two factors distinguish the current debate from the vitalism - mechanism conflict at the beginning of this century. One factor, well documented by Professor Behe, is our knowledge of the molecular components of complex biochemical systems. We cannot make simplistic assumptions because the hard facts of molecular genetics, DNA sequencing, and protein biochemistry tell us that complexity is truly the name of the game in biology.

The second new factor, strangely ignored by Professor Behe, is the existence of computers and information networks. Having exemplars of physical objects endowed with computational and decision-making capabilities shows that there is nothing mystical, religious, or supernatural about discussing the potential for similarly intelligent action by living organisms. Information science also provides new conceptual frameworks for analyzing, formalizing, and ultimately exploiting the intelligent behaviors of complex biological systems. We need only think of the many applications of hybrid concepts like neural networks and genetic algorithms to realize the enormous potential of the interface between information science and biology. Exploring this interface, science is about to enter a period as exciting and transforming as the physics of the early twentieth century. Sadly, despite its valuable critique of an all-too-often unchallenged

orthodoxy, Darwin's Black Box fails to capture the true excitement of contemporary biology because it is fighting the battles of the past rather than seeing the vision of the future.