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There is now general agreement that the twenty-first century will be the century of biology. The twentieth century was the century of physics. But biology has now larger budgets, a larger workforce, and biological discoveries surpass the achievements of physics in scientific significance and their relevance to human life.

The twenty-first century faces two major issues in human biology: the brain-to-mind transformation and the ape-to-human transformation. By the brain-to-mind transformation I refer to the puzzle of how the chemical and electric signals, with which neurons communicate with each other, become transformed into perceptions, feelings, ideas, critical arguments, aesthetic emotions, and ethical and religious values. And how, out of this diversity of experiences does a unitary reality emerge, the mind or self. By the ape-to-human transformation I refer to the question of how the seemingly small 1 percent difference, out of three billion nucleotides, between the human and the chimp genomes accounts for the important biological and behavioral differences between the two species. Humans have bipedal gait and a much larger brain and we have language, technology, art, ethics, and religion.

Twenty-first century biology has and will have practical consequences of unprecedented magnitude, for good and possibly for evil. Comparison of human genomes with each other and with the genomes of other organisms, with that of the chimp and those of many other species, will identify the genetic underpinnings of many diseases and make possible the development of effective curative drugs and vaccines. The beneficial applications of biotechnology will go incredibly further than what has been accomplished in the twentieth century and will improve the food supply in the Third World while reducing the land committed to agriculture.

But food technologies can harm the environment and human health. Steroids, growth hormones, and genetic engineering pose threats that must be faced by individuals and societies. Twenty-first century biology and the biotechnology and new medicine derived from it, will raise unprecedented ethical questions, unprecedented not only because they are new but also because of their magnitude in the number of people who will be affected and in their life-and-death consequences. Ethicists have started to respond to the present and anticipated challenges with professional organizations, new journals, proclamations, and a great diversity of treatises and monographs.

The pernicious possibilities of genetically engineering "enhanced" humans have been effectively raised in works, such as the recent and suitably gloomy *The Case against Perfection. Ethics in the Age of Genetic Engineering* (Harvard University Press, 2007) by the philosopher Michael J. Sandel. Numerous bioethics monographs and textbooks focus on biomedicine subjects, such as organ production and transplantation, stem cell research, prenatal diagnosis and abortion, artificial insemination and in vitro reproduction, nuclear transfer and cloning, eugenics and euthanasia. Some treatises focus on ethical issues that go beyond biomedicine into genetic engineering, which is being proposed both for therapeutic purposes and with enhancing goals, for the individual's benefit and beyond germline intervention. Some explore the possibilities of "designer babies" and of a genetically-engineered "Brave New World", usually to deplore such options, present and future, as the end of reason or of humanity as we know it. The *Encyclopedia of Bioethics*, Third Edition (Macmillan Reference, USA, 2003) covers the whole spectrum of subjects, extending to the environment, overpopulation, and the sky-rocketing medical costs.

*Bioethical and Evolutionary Approaches to Medicine and the Law* is exemplary.
Weighing-in at more than 1200 large-size pages, it covers issues of applied bioethics in extended detail and in depth. But, importantly, it dedicates the first six chapters (361 pages) to the legal, scientific, philosophical, and religious foundations of bioethics, particularly biomedicine. This is fitting given the author's broad expertise and experience. W. Noel Keyes holds a law degree from Columbia University, a doctoral degree from the University of Paris, further studies in Rome, and many years of law practice in the states of New York, New Mexico, and California in the United States. More recently, he taught law courses at Pepperdine University in California and served for many years on the Hospital Ethics Committee of the University of California at Irvine.

Keyes sees the scientific foundations of bioethics in the theory of evolution, which accounts for the origin of life and of humans and, thus, becomes a necessary source of reference when seeking to establish life and human values, where bioethics should be grounded. He has little patience with modern critics of the theory of evolution, such as the creationist-intelligent designer biochemist Michael Behe, who has outrageously claimed that “There is no publication in the scientific literature — in prestigious journals, specialty journals, or books — that describes how molecular evolution of any real, complex, biochemical system either did occur or even might have occurred ... Unlike Darwinian evolution, the theory of intelligent design is new to modern science” (cited in Bioethical and Evolutionary Approaches, pp. 48-49). The notion of intelligent design, contrary to Behe's egregious claim, is not new. St. Thomas Aquinas famously had, in mid-thirteenth century, set up the argument-from-design as the “fifth way” to demonstrate the existence of God: “We see that things that lack intelligence act for an end, which is not fortuitous but results from design ... directed by some being endowed with knowledge and intelligence.” The argument-from-design for the existence of God would be formulated much later by the English clergyman William Paley in his Natural Theology (1802). Famously, Paley compared a telescope and the human eye, arguing that both were designed, one by a telescope maker, the other by the same Power who had also created the immense diversity of organisms. Paley's argument crumbled, of course, after Charles Darwin's discovery of natural selection, which provided a scientific explanation of the design of organisms.

Yet, in the 1990s, particularly in the United States, several authors, notably Behe, theorist William Dembski, and law professor Phillip Johnson, among others, have revived the argument from design. “Intelligent design” is bad science or not science at all. It is not supported by experiments, observations, or results published in peer-reviewed journals. It is also bad religion and bad theology, because it implies that the “designer” has undesirable attributes that people of faith do not want to predicate about God: incompetence, cruelty, and even sadism and perversion.

With critical reference to proponents of intelligent design and other creationists, Keyes writes: “Today ... men must learn to act responsibly when making ethical and legal choices” (p. 49). I salute with respect W. Noel Keyes, an ethicist lawyer, who writes an extended section on “The Importance of Considering the Meaning of Evolution” (pp. 54-63) and goes on to dedicate additional sections to “Evolutionary Advances in the Third Millennium” and “A Key to the Basis of Significant Contingencies (Not Design) in Evolution”. Keyes has chapters on “Religious Sources ... and Their Possible Bioethical Standards” and on “Difficulties with Science and Philosophy in the Search for Bioethical Standards”.

The “heart” of Bioethical and Evolutionary Approaches, where the bioethical issues are considered at length, are the nine chapters of Parts II, III, and IV (pp. 363-1019). The topics include family planning and birth control; infertility and cloning;
prenatal counseling and abortion of choice; severely defective premature infants; organ transplants for newborns and for adults; the right to death with dignity; the right to choice in terminal patients; and much about genomics, from the human genome project and genetic approaches to disease, to genetically modified plants and genetically engineered new forms of life.

*Bioethical and Evolutionary Approaches to Medicine and the Law* has been published by the American Bar Association. It is heavily documented in thousands of extended footnotes, much as it is typical of law journals and law books. Unfortunately, it is not as carefully edited as it deserves to be. There are unseemly typographical errors, erroneous citations, and other mishaps, which should be corrected when this fruit of many years of labor by the author becomes reprinted or reaches a second edition.

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This book, like its forerunner *Critical Rationalism: a Restatement and Defence* (1994), is a polemical restatement of Sir Karl Popper’s theory of knowledge – Critical Rationalism (CR). It is not the only undertaking of this sort but insofar as Popper’s fundamental views on scientific method are concerned, Miller’s is probably the most faithful and austere account of CR. As he notes in the preface, “CR has never been an easy position to adopt” (p. ix). And, let me add, the more rigorous its statement, the more incredible it sounds. This is so not because CR declares all knowledge fallible and inductive logic a mirage. Indeed, on this very precept most philosophers will agree. Rather, what sounds so incredible is Miller’s uncompromising assertion that empirical justification is untenable and unwarranted because science advances on guesswork (conjectures) and the elimination of errors (refutations). As conjectures and their refutations are in principle empirically unjustifiable and as scientific knowledge consists of nothing then these, scientific knowledge “is never more than a wild conjecture at the truth”. Incredible indeed.

The book is a well-structured compilation of essays and lectures written since the death of Popper in 1994. It opens with a scientific memoir of Popper and closes with a personal memoriam. The scientific memoir is a stunningly clear and succinct account of Popper’s professional and intellectual life, the development of his interests and ideas, and the novelty of his contributions to an astonishingly wide range of fields – from logic and probability theory, through methodology, to physics, evolutionary biology, ethics and politics. Chapter 2 spells out the central components of CR. First is fallibilism – the denial of certainty of any factual knowledge. Second is negativism or falsificationism – the advocacy of the method of error elimination. Third is radical scepticism – the view that nothing in science is knowable with any positive degree of justification.

This triple scheme sets the tone throughout the book although not evenly, for not much is said about the negativism that according to CR is the method that science follows. Thus, in chapter 3 Miller contends that valid arguments are effective only as instruments of criticism but they “make no attempt to explore the world, but only to explore the conjectures that we already entertain about the world” (p. 69). This is a strange and rather questionable claim, for although it is a (logical) fact that the premises (or axioms) of a theory “encapsulate” all its (infinitely many) logical consequences, it