Biotechnology and Conceptualizations of the Soul

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In 1970, Jacque Monod, a Nobel Laureate and a founding father of molecular biology, wrote a short celebrated book entitled *Chance and Necessity*. In it, he explained why he thought genetic engineering of any organism was impossible:

> Modern molecular genetics offers us *no means whatsoever* [original emphasis] for acting upon the ancestral heritage so as to improve it with new features . . . on the contrary, it reveals the vanity of any such hope: the genome's microscopic proportions today and probably forever rule out manipulation of this sort.[1]

Monod's "forever" ended a scant three years later when the "means" for manipulating microorganisms was invented, and modern biotechnology was ushered into the world. In 1980 we saw the successful genetic manipulation of mammals, and over the next two decades, biotechnology became more and more sophisticated as it became applied in thousands of ways to "microscopic genomes" in hundreds of species of microbes, animals, and plants.

Biotechnology is generally defined as the controlled development or use of living organisms or their component parts to produce substances or carry out processes that are of value to individual people or societies. Genetic engineering was first perfected on microbes, which have served as living factories for the production of medicines and other products of commercial value. By the mid 1990s, the first commercial applications of plant and animal engineering were developed. And as we enter the new millennium, a new phase of biotechnology has begun with the development of methods for growing human stem cells and differentiating them (based on genetic understanding) into tissues that could be used to treat a variety of diseases.

As the power of biotechnology has exploded over the past decade, it has evoked an enormous backlash of opposition. Even as scientists argue that biotechnology can alleviate human suffering, increase productivity, and protect natural resources, opponents argue that it will degrade human life and destroy the environment. As the debate becomes more and more heated, proponents and opponents seem to be talking right past each other. The frustration of scientists can be gauged in a comparison of the consideration that Americans give to two types of products that are each currently in the marketplace.

The first product has been responsible for the deaths of hundreds of people—including, most recently, a 23-year-old minor league baseball player named Steve Bechler—and severe adverse reactions including heart attacks, vomiting, and stroke in thousands of other Americans who consume it.[2] The second

Cambridge Quarterly of Healthcare Ethics (2003), **12**, 335–341. Printed in the USA.
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product has been eaten by hundreds of millions of people without ever causing a single documented negative health reaction of any kind.

The first product—a convicted killer called ephedra—is not subject to any kind of U.S. regulation, in either production or sale, and most members of the American public want to keep it that way. The second product—genetically modified crops (GMOs)—has caused public outrage and violent protests, and its consumption is essentially banned (in effect, if not law) across the European Union.

Ephedra is the genus name of a group of plant species that grow wild in Asia. It is just one of thousands of botanical preparations often sold in "health food stores" as "dietary supplements." Because they are natural "organic" substances, they can be marketed without any proof of composition, safety, or efficacy—indeed without any oversight at all—in the United States. Americans spend $17 billion per year on their consumption.[3]

In contrast, according to a newly enacted U.S. Department of Agriculture regulation, if a plant is genetically modified in any way, neither it nor any of its descendants can be considered "organic" for the purposes of consumer labeling.[4] (According to Richard Wiles, vice president of the Environmental Working Group, "organic is the gold standard for chemical-free food."[5]) The antibiotechnology activist Jeremy Rifkin has coined the term "genetic pollution" to describe the impact of genetic modification. And in the United Kingdom, genetically modified foods have been nicknamed Frankenfood.

What is going on here? Why do so many people seethe with such fundamental fear and hatred of a particular *way of producing* things rather than any particular *result* or *product*? Part of the answer lies in political opposition to capitalism and globalization. But sales of nutritional supplements bring big profits to large corporations, and biotechnology is just one of many capitalist tools that can be used to either good or bad effect, for profit or not. (Ironically, nonprofit humanitarian and proenvironmental applications of biotechnology are likely to be the first casualties of politically motivated antibiotechnology fervor.)

I believe that much of the opposition to biotechnology—from the left, right, and middle of the political spectrum—is based overtly, covertly, or unconsciously on the fear that biotechnology, by its very nature, infringes on the *soul* or *spirit* of individual organisms and Mother Nature as a whole. Nevertheless, seasoned players on both sides of the political debate studiously avoid any mention of the soul or spirit. Biotech opponents want to appear rational and scientific; biotech proponents don't want to offend religious sensibilities or frighten people with the very real, life-altering power of their technology.

Is the *soul* a useful concept? Many intellectuals think not, or at least choose to behave as if the subject were fundamentally unsuitable for examination or discussion. But it is absurd to ignore a nearly universal belief that extends across every human culture around the world and lies at the core of emerging debates over the uses to which biotechnology can be put in the plant, animal, and human realms. Productive engagement in the debate requires a critical analysis of the diverse ways in which the soul is conceptualized in the minds of different people.

The problem is that defining and characterizing existing notions of soul is fraught with difficulty. Every major view comes in a broad range of hues, and many concepts are fuzzy, obscure, or logically inconsistent. Notions of souls are

often, but not always, intertwined with broader systems of religious belief or faith in God or other supernatural entities. With an understanding of the impossibility of the task, I will attempt to provide an overview of the major categories of soul belief in relation to scientific formulations of the physical and biological worlds.

The place to start is with Aristotle, the first scholar to articulate a sophisticated (for his day) science of the soul.[6] To Aristotle, aliveness and soul are one and the same. In this view, it is no more reasonable to claim the nonexistence of the soul than it is to claim the nonexistence of life. The soul is the essence of a living thing; an expression of the organic material that defines an individual organism. It cannot survive death or exist in isolation from organic bodies.

Aristotle's biological studies allowed him to make a conceptual leap that is critical to current discussions about the sanctity of life. *Being alive*, he asserted, is fundamentally different from *having a mind*, and different kinds of souls are associated with each of these states. According to Aristotle, all living things are animated with an unconscious vegetative (or nutritive) soul that performs metabolism and guides growth. However, he also argued that the developing structure of an animal body produces a higher level of sentient soul. (A modern interpretation of the sentient soul would place it in direct association with a functioning brain of some kind.) Finally, Aristotle assumed that mature human beings are as different in kind from animals as animals are from plants because of a third-tiered rational (or human) soul that emerges during fetal development, on top of the previously formed sentient and vegetative souls. (The medical term "persistent vegetative state" derives from Aristotle's notion of a layered soul. The term describes a person who can breath spontaneously but shows no evidence of sentience or awareness.)

The Aristotelian division of souls into vegetative, sentient, and human types doesn't prescribe their intrinsic natures. It once seemed reasonable to assume that the material substance of living things—organic matter—is fundamentally different from nonliving inorganic matter, and this difference in the material substance itself is responsible for the soul, or souls. With early advances in chemistry and physics, it became clear that organic matter is composed of the same constituent atoms that are present in nonliving things. This knowledge led many people toward vitalism, the belief that special "vital forces" are required to organize, animate, and direct the ordinary atoms and molecules within living things; the summation of these vital forces within an individual organism represents the soul.

With advances in molecular, cell, and developmental biology, biologists have obtained a powerful conceptual framework for explaining Aristotle's vegetative soul as a coherent dynamic network of information processing carried out by complex organic molecules, all acted on by the standard forces defined by the laws of physics. In the not-too-distant future, scientists will succeed in computer modeling the entire process for simple real-life organisms without any recourse to vital forces.

The sentient and rational souls are not quite as far along the line of scientific understanding. Perception, learning, memory, and other mental activities have been definitively associated in the modern era with the activity of neurons in particular regions of the brain. Human emotions and personality are readily modulated by altering levels of the specific chemicals used by neurons to communicate with each other. And when scientists peer deep inside neuronal

cells or the brain as a whole, they do not *need*, nor do they *find*, any vital force or energy to explain the molecular activities associated with mind. But few scientists believe that we will soon have a computer model that simulates consciousness.

Even with a modern-day education, most people are convinced that consciousness cannot be explained by molecules and neurons alone. In contemporary culture, vital forces have been replaced by immaterial spirits (which serve the same role). In an anonymous survey of undergraduate students at Princeton University—who are representative of the most highly educated young people in the United States—39% said they believed in the existence of a nonphysical human spirit responsible for consciousness, 37% were not sure what they believed, and only 13% were convinced that human spirits did not exist.

In fact, the majority of Americans, as well as 26% of Princeton students reject the Aristotelian framework of layered souls that mirror biological complexity. (Another 33% of Princeton students are not sure about this interpretation.) Instead, they divide living things into human and nonhuman categories and posit the existence of a God-given human-specific spirit that is in place throughout all stages of human development from conception to death and beyond. This single unified spirit is accorded multiple roles. It is responsible for the unconscious *development* and *maintenance* of the body, it is equivalent to *mind* in a mature human being, and it retains the *essence* of the person in a nonmaterial afterlife.

Not unexpectedly, those who hold such a spiritual view of human life are opposed to human embryo research, even if its purpose is to develop therapies for treating human disease. But prominent neoconservative public intellectuals, including Leon Kass, Robert George, Charles Krauthammer, and Francis Fukuyama—all members of President Bush's Council on Bioethics—claim their opposition to research on human embryos has nothing to do with the soul or spirit. Instead, they declare that their views are based on a "fundamental truth" about the moral value of "all forms of human life."

Are these intelligent scholars really confused about the distinction between life and mind, delineated by Aristotle over 2,000 years ago? Far from it! They know that the overt imposition of religious concepts on political decisions is anathema to many mainstream Americans who, nonetheless, believe in the sanctity of some form of human spirit. Therefore, it becomes politically expedient to drape a secular veil over spiritual convictions, replacing the notion of "the sanctity of the soul" with "the dignity of human life." In a recently submitted 120-page majority report titled "Human Cloning and Human Dignity," the President's Council on Bioethics avoided all references to soul and spirit in its argument against embryo cloning for biomedical research. This strategy is brilliant and effective because secular opponents are reluctant to engage in a direct public discussion about the imagined nature of the human soul. As a consequence, lay people are led to believe that a scientific justification might exist for equating human embryos with human beings. A few prominent academics, such as the bioethicist Arthur Caplan[7] and the neuroscientist Michael Gazzaniga[8] (a dissenting member of the Council on Bioethics) have accused Kass and his like-minded colleagues of intellectual dishonesty and obfuscation, but even these critics have been unwilling to use the term "soul" in their writings. Unfortunately, when supporters of biomedical tech-

nology or abortion rights allow their opponents to define the terms of the debate in this way, their positions are immeasurably compromised.

At the opposite end of the cultural spectrum are spiritualists of a different breed. They reject a traditional belief in a God-given spirit from "above" and replace it with a pantheistic belief in a spirit that emerges from *Mother Nature* "below." New Age pantheism can combine aspects of animism and spiritualism to project a unified spirit or soul onto an entire species, an ecosystem, or earth's "biosphere" as a whole. Thirteen percent of Princeton students are convinced that "groupings of multiple organisms" can have a unified spiritual soul, and another 28% have not ruled out the possibility. In the broader cultures of America and Europe, the numbers are likely to be much higher.

For purposes of political persuasion, organizations that object categorically to all GMOs usually allege threats to human health or the environment. But beneath this veil of scientific concern (which may or may not be scientifically valid in each individual case) lies a fundamental belief that genetic engineering somehow wounds or disrupts the vital energy or spirit that animates Mother Nature.

What few people know is that many commonly consumed natural foods, whether "organic" or not, contain multiple chemicals classified as carcinogens or toxicants.[9] Potatoes contain the poison arsenic (and other toxicants and carcinogens); lima beans contain another well-known poison, cyanide; bread contains the neurotoxin-carcinogen acrylamide, and coffee contains 14 known carcinogens, including benzaldehyde and hydroquinone. Nevertheless, scientists and government regulators don't worry much about these and most other foods. Their toxic or carcinogenic ingredients are present at such low levels that the risk posed to human health is negligible compared to other risks we accept routinely in our everyday lives.

One exception is the potent cancer-causing chemical aflatoxin produced by a mold that grows naturally on peanuts and other grains. Ironically, for those who shun food preservatives, preservative-free peanuts and peanut butter are much more susceptible to aflatoxin contamination than peanuts containing BHT or BHA (common preservatives that haven't exhibited any evidence of negative health effects in billions of consumers).[10] In other cases, the parts that we don't eat of some plants (e.g., leaves on tomato vines) are extremely toxic and potentially lethal if ingested.

Natural carcinogens and toxins are *never* produced by *accident* in plants or microbes. They are complex chemicals constructed through the joint activities of proteins encoded in multiple genes that have been honed over millions of years of evolution to protect their hosts from invasion or ingestion by other living things. Scarcely anyone outside the scientific community is aware of their presence in common foods because the popular media are strongly influenced by the powerful, but false, assumption that nature has an overarching beneficent spirit (unlike synthetic artifacts, which are spiritless).

Among the many outcomes of biotechnological research over the past 30 years has been the ability to assess—at the design stage—whether plants engineered to produce specific new substances pose any significant new risk to human health. Again, few people realize that current GMO products contain only one or several very well defined new proteins added to the tens of thousands of different types of proteins and other chemicals present naturally in every bite of food we take (most of which remain undefined). It is impossible

for any protein, natural or added in, to cause cancer when ingested. In general, the risk that genetic modification might *accidentally* cause a plant to produce a substance that is toxic to people in any way is vanishingly small.[11]

What can genetic engineering do that Mother Nature or humankind hasn't done already? The products of genetic engineering are organic creatures, not chemical pollutants or carcinogens (unless they are specifically designed to produce such substances). Genetic engineering can alter existing genes or move genes from one species to another, but we now know that Mother Nature does all of this routinely as well. I do not mean to imply that genetic engineering cannot cause harm to humans or ecosystems. First, it is certainly possible for scientists to design novel disease-causing creatures (although it will be hard for them to beat what Mother Nature already serves up in the form of anthrax, smallpox, *Clostridium botulinum*, which causes botulism, or *Yersinia pestis*, responsible for bubonic plague).[12] Second, it is true that, in some situations, the risk exists for genetically engineered traits to migrate unintentionally into wild plants. In some such cases, the genetically engineered trait could alter a natural ecosystem in a significant way. Indeed, scientists take this risk much more seriously than alleged health risks. With a scientifically informed regulatory process, the risk of significant eco-harm can be assessed up front and used in the decision to implement, redesign, or reject a particular GMO on a case-by-case basis. (The terminator technology, which would make genetically engineered plants sterile, could be used to prevent accidental introgression into other plants, but antibiotech activists were so offended by this idea that they succeeded in halting its development beyond the conceptual stage.)

So, why does biotechnology elicit revulsion among so many people whereas Nature elicits reverence? The answer is rooted in the pervasive pantheistic belief in the natural benevolence of Mother Nature, a concept that is reinforced in schools throughout America and Western Europe. And what could be worse than a technology—like genetic engineering—that violates a mother's soul?

There is no other way to explain the actions of Western news media that routinely highlight alleged dangers of genetic engineering while failing to provide positive coverage of genetically engineered products that could greatly benefit humankind. The harms allegedly caused by genetically enhanced corn alone include allergic reactions, damage to the iconic monarch butterfly, and "genetic pollution" of Mexico's "pristine" native crops—all reported by the well-respected *New York Times*. In fact, all of these claims were based on biased experimental protocols, poorly interpreted results, purposely falsified data, or no supportive data at all (in the case of allergies). In contrast, when a nonprofit Swiss institute announced its creation of a golden variety of rice producing vitamin A and greatly increased levels of iron (to overcome blindness and nutritional deficiencies in Third World Asiatic countries), this accomplishment was virtually ignored or condemned as a public relations stunt (which it was), without explanation of its potential humanitarian benefit.

I must emphasize again that I am not attempting to argue that all products of genetic engineering hold no risk. I am simply pointing out that risks are routinely invented even when scientific understanding and empirical data show that such claims are exaggerated or simply false. Furthermore, what GMO detractors fail to consider is the human cost of *not* using GMO products. One tragic consequence of this approach was illustrated in the fall of 2002 in the African country of Zambia. As millions of his citizens suffered on the brink

of starvation due to an extended drought, Zambia's leader, Levy Mwanawasa, refused to accept the humanitarian donation of milled genetically modified corn from the United States because he did not want his people to eat "poison." (The same corn had already been eaten by more than 100 million Americans without a single instance of ill health effects.) Adhering blindly to their anti-GMO agenda, leaders of the antibiotech movement failed to step in to assure Mwanawasa that his people would be better off eating genetically modified corn than starving to death.[13]

Every use of biotechnology is an assault on the soul defined by one belief system or another. Both biotechnology and society as a whole would be best served if scientists acknowledged this cultural fact and responded to it directly in public debates and decisions to develop and implement each new biotech application.

Notes

1. Monod J. *Chance and Necessity*. Glasgow: Collins; 1970.
2. Grady D. Seeking to fight fat, she lost her liver. *New York Times* 4 Mar 2003:F1.
3. See note 2, Grady 2003.
4. Agricultural Marketing Service. National Organic Program standards. Available at: http://www.ams.usda.gov/nop/NOP/standards/FullRegTextOnly.html.
5. Becker E. Organic gets an additive: A USDA seal to certify it. *New York Times* 21 Oct 2002:A10.
6. Aristotle. On the soul. In: Barnes J, ed. *The Complete Works of Aristotle: The Revised Oxford Translation*. Princeton, N.J.: Princeton University Press; 1984:641–92.
7. Caplan AL. The attack of the anti-cloners. *The Nation* 17 Jun 2002.
8. Gazzaniga M. Personal statement. In: President's Council on Bioethics, eds. *Human Cloning and Human Dignity: An Ethical Inquiry (July 2002)*. Washington D.C.: President's Council on Bioethics; 2002.
9. American Council on Science and Health. Holiday dinner menu. Available at: http://www.acsh.org/publications/booklets/menu02.html; Gold et al. Possible carcinogenic hazards from natural and synthetic chemicals: setting priorities. In: Cothern CR, ed. *Comparative Environmental Risk Assessment*. Boca Raton, La.: Lewis Publishers; 1993:209–35. Our dietary intake of natural pesticides and carcinogens is far greater than our intake of synthetic pesticides.
10. The Institute of Medicine. *Eat for Life: The Food and Nutrition Board's Guide to Reducing Your Risk of Chronic Disease*. Washington D.C.: National Academy Press; 1992:3, 130.
11. Some proteins can cause an allergic reaction in a small percentage of people. Potentially allergenic proteins have a particular chemical structure that is easy for scientists to recognize. Unlike 99% of naturally occurring proteins, allergenic proteins are all resistant to normal digestion. Their persistence in the digestive tract can elicit an allergic reaction in some people with a dysfunctional immune system. (Not all persistent proteins cause allergies.) Among the most allergenic proteins known are several produced naturally in peanuts, which are responsible for approximately 100 deaths a year in the United States. One of the first applications of GMO technology has been the production of crops with a BT protein that provides plants with resistance to insect pests. The BT protein has a structure that is potentially allergenic, but there is no evidence that it has actually caused an allergy in any person. Most of the proteins that have been engineered into crops have no chance of causing allergies. Furthermore, one of many applications of GMO technology is the modification of allergen-producing genes so that peanuts and other naturally allergenic products can be made less allergenic.
12. Those intent on using genetic engineering to develop *more* lethal biological weapons are sure to start with an organism that is already lethal, such as one of those mentioned.
13. The fear factor [editorial]. *Nature Biotechnology* 2002;20:957.