

Biological Engineering for Fun and Profit

In the July, 2007 issue of *New York Review of Books*, physicist Freeman Dyson heralded a coming era of “user-friendly” genetic engineering kits. At that time the first step, according to this high-profile scientist, had already occurred: genetically modified tropical fish with new and brilliant colors had appeared in pet stores. Still to come, he prophesied, were do-it-yourself kits enabling gardeners to “breed” new roses and orchids, and animal lovers to create previously unknown varieties of pigeons, parrots, lizards, and snakes, not to mention dogs and cats. “Designing genomes,” Dyson claimed, “will be a personal thing, a new art form as creative as painting or sculpture.” Then the final step in the “domestication of biotechnology” will be biotech games

designed like computer games for children down to kindergarten age but played with real eggs and seeds rather than with images on a screen. Playing such games, kids will acquire an intimate feeling for the organisms that they are growing. The winner could be the kid with the prickliest cactus, or the kid whose egg hatches the cutest dinosaur.

Dyson acknowledged that these games “will be messy and possibly dangerous,” but this concern hardly vitiated his enthusiasm, and he seemed to have little doubt about the scientific precision of the underlying procedures, at least when performed by knowledgeable adults. “Guided by a precise understanding of genes and genomes instead of by trial and error, we can within a few years modify plants so as to give them improved yield, improved nutritive value, and improved resistance to pests and diseases.”

So far as that “precise understanding,” is concerned, the interested reader should refer to The Nature Institute’s <http://nontarget.org> website. Few biologists today who actually work at trying to understand the organism at the molecular level (as opposed to physicists writing outside their field) would make the claim of precision. After all, if our knowledge was at all precise, we ought (according to the doctrine of molecular determination of the organism) to have “conquered” cancer long ago—or at least to have figured out what the problem is. But, in any case, lack of understanding has never been an obstacle to those who view the natural world as a playground for unrestrained

manipulation. And nothing has happened during the less than four years since Dyson’s article was published to suggest that his prediction of widespread manipulation for fun and profit was incorrect.

Take, for example, Ingmar Riedel-Kruse, a bioengineer who asked himself why there shouldn’t be video games using live microbes. He and his colleagues developed a game console that, according to *Science* magazine, “nudges paramecia around a microfluidic chamber with chemical gradients or mild electric fields.” Games include Ciliaball, a soccerlike entertainment, and Pond Pong, “in which two players bat the microbes back and forth by releasing chemicals from a needle tip.” A microscope camera projects the fun onto the game window.

That might seem fairly innocuous, since the organisms are not actually genetically engineered. If you yearn for the deeper joy of re-making organisms in order to satisfy your own artistic whimsy, you can only envy the poet, Christian Bök, who was given the privilege of devoting some \$16,000 to the realization of his dream. He chose to create an organism with inserted DNA that, according to an arbitrary mapping scheme in his own mind, encoded some of his poetry. “I hope,” he told the journal *Nature*, “to be among the first poets to make a work of art out of such a burgeoning technology.”

Then there is Meredith Patterson, “a computer programmer turned biohacker by night,” according to a December, 2008 article in *The Times* of London. “In her San Francisco dining room Ms. Patterson is currently attempting to rewire the DNA of yoghurt bacteria so that they will glow green to signal the presence of melamine, the chemical that infamously turned Chinese-made baby milk formula into poison.” This illustrates how easily playing with the molecular processes in organisms can be hitched to “socially redeeming” causes.

Can it also be hitched to some very, very bad accidents? It doesn’t seem to matter. “The growth in popularity of biohacking seems unstoppable,” writes *The Times*. And when a reporter put the question of terrorist opportunities to Ms. Patterson, she shrugged, “A terrorist doesn’t need to go to the DIYbio [Do It Yourself Biology] community. They can just enroll in their local college.”

As for those socially redeeming aspects, few would question the cause, if not the proposed solution, that empassions

Adam Shriver, a doctoral student in philosophy/neuroscience/psychology at Washington University. He is concerned about the pain that veal calves and gestating sows suffer as a result of their unnatural diets and feedlot conditions. And so, in a *New York Times* Op-Ed piece (Feb. 19, 2010), he urged that the animals be genetically engineered to remove the awareness of pain. “If we cannot avoid factory farms altogether, the least we can do is eliminate the unpleasantness of pain in the animals that must live and die on them. It would be far better than doing nothing at all.”

Shriver’s proposal was directed at the professional research community. But there are now various organizations, such as BioCurious and DIYbio, whose aim, in part at least, is to encourage the general public to indulge their taste for imposing their own fantasies upon other organisms. There’s also an International Genetically Engineered Machine competition for undergraduates. The sponsoring organization writes: “Student teams are given a kit of biological parts at the beginning of the summer from the Registry of Standard Biological Parts. Working at their own schools over the summer, they use these parts and new parts of their

own design to build biological systems and operate them in living cells.”

By now the trend has, it seems, accelerated altogether beyond control—if control was ever even possible. And while professional researchers in molecular biology have some ethics guidelines and protocols for preventing the unwanted release of engineered organisms into the environment, the same is hardly true of do-it-yourselfers laboring away in their kitchens.

What can one say in response to this chaotic mixture of noble aspirations, utter pettiness, hell-bent recklessness, and cavalier experimental curiosity—all marked by an apparently total disinterest in the living organisms being manipulated? Nothing much, I’m afraid, in just a few words. Perhaps you, like me, are rendered temporarily speechless by the kind of thing described above. There is, however, at least this: it all says something about why an organization such as The Nature Institute is needed in today’s world! (Beyond that, I do hope before long to post a major essay on our website, which I’ve written for a book on bioethics to be published by the Hastings Center.)

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A Modest Champion of the Whole Organism

Whenever I hear it said that “the whole is greater than the sum of its parts,” I find myself wondering (rather uncharitably, perhaps) whether the speaker has any more understanding than I do of what the words might actually mean—or whether (as it often sounds to my ears) the cliché is merely an expression of feel-good, more holistic-than-thou sentiment. Why, if the thought is so important, do we almost never hear its meaning spelled out—or at least not spelled out in a way that makes much sense?

I readily grant that I, too, have always believed the phrase to conceal something important, despite my inability to do justice to its meaning. One offhand remark that stimulated my thought on the matter came from physicist Arthur Zajonc a few years ago, when he said something roughly to this effect:

If people really believe a whole is greater than the sum of its parts, we should ask them to identify the “greater” reality that remains to be recognized once all the parts have been summed up.

I did in fact occasionally pose that question to others, but without promising result. While I had my own vague intuition of the matter, it never gained the clarity I would have liked.

You can imagine my delight, therefore, when I encountered a straightforward and decidedly non-clichéd interpretation of the phrase from a leading cell biologist of the twentieth century — an interpretation proffered in reassuringly dry, matter-of-fact language unlikely ever to become the clarion call of a New Age. In fact, the author of the interpretation often put his meaning into a mathematical formula—one surely never destined for the fame of $E=mc^2$, but perhaps fully as important once we realize its implications for our understanding of living organisms:

$$V_S < (v_a + v_b + v_c + \dots v_n)$$

Don’t worry, however. There’s no need to consider the formula here. The whole matter can be explained without a formula, and with clear examples. For those interested, I’ll save the explanation of the formula itself (which will require all of a sentence or two) for later.