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## Killer potatoes: Where's the data?

What are we to make of the firestorm surrounding Arpad Pusztai's transgenic potato research? The storm—only one of many biotechnology conflagrations now raging across Europe—is all the more remarkable because the work at the center of the controversy has never been published or peer-reviewed.

Last August, during the British documentary TV program *World in Action*, Pusztai, a scientist at UK government-sponsored Rowett Research Institute (RRI) in Aberdeen, Scotland described how five rats fed genetically modified (GM) potatoes containing insecticidal lectin concanavalin A (Con A) had slightly stunted growth, while their lymphocytes demonstrated a suppressed response in vitro to mitogenic stimuli. The press response to his remarks was predictably instantaneous and alarmist.

RRI began sending out press releases, initially in support of Pusztai, a well-regarded researcher in the area of GM food safety. But almost as quickly they retracted their support. After performing an audit on the work that had generated all the publicity, RRI came to the conclusion that the feeding trials involving GM Con A had been prepared but not completed and announced Pusztai's suspension from the studies and retirement from the institute. Then, in February, 23 scientists—none of them apparently transgenic food researchers—issued a public statement claiming that

Pusztai's original results were valid and that he should be reinstated posthaste.

Based on Pusztai's unpublished research, UK political factions are now calling for moratoriums on GM research and GM foods and for the resignation of one or more government members. There are accusations of conspiracy and coverup, of big companies paying off little institutes to suppress data and allegations of wealthy members of parliament with vested interests in the technology putting profit before safety. Given the pandemonium, the message to the public is confusing and disturbing.

The real food safety issues at the heart of this controversy have become obscured by economic, political, ideological, and aesthetic issues. But whether we want or need or like or value transgenic foods has nothing to do with whether they are safe. One can only hope that the parties involved will declare a moratorium, not on GM crops and foods, but on public discussion that is almost completely devoid of verifiable information. RRI and Dr. Pusztai should present their data for peer review (and we invite them to do so) so that it can be considered in the context of work already undertaken or underway concerning the safety of these products. The promise of agricultural biotechnology as a means of diversifying agriculture and rendering it more efficient deserves as much.

## More gods and monsters

As though it were not enough that biotechnologists are meddling with our food, now the media claims they are on the verge of creating life. To a packed auditorium at the latest meeting of the American Association for the Advancement of Science in Anaheim, J. Craig Venter, former head of the Institute for Genome Research (TIGR) and president of Celera Genomics, announced that he was near to discovering the minimum set of genes a cell needs to stay alive and reproduce. In addition, he said that this might ultimately lead to the creation of the world's first artificial living organism.

For some time, Venter and his coworkers at TIGR have been studying the genome of *Mycoplasma genitalium*, an extraordinary bacterium that parasitizes the human respiratory and urogenital tracts. *M. genitalium*'s genome was first sequenced at TIGR in 1997; incredibly, it contains a complement of only 470 genes, the smallest known genome of any organism.

Using transposon mutagenesis, Venter's team have analyzed *M. genitalium*'s genome, identifying as many as 140 "nonessential" genes that appear dispensable for growth and replication. The problem is that without knocking out all of the genes in one experiment, it is impossible to tell whether other genes can supplement for these "nonessential" genes when they are knocked out in isolation. As transposon mutagenesis is incapable of accurately knocking out 140 genes in a genome at the same time, the only way to create a cell containing the supposed 330 "essential" genes would be to assemble a bacterial artificial chromosome (BAC) from scratch. By placing such

a BAC in a bacterial cell lacking its natural genome (a type of minicell if you will), Venter hopes that, with the right ingredients, life will arise spontaneously.

To many, the notion that such an experiment is being contemplated seems more than a little premature. We don't even know how to stitch 330 genes together, let alone have a theory of life to explain how we could coordinate them to produce a replicating organism. If one believed the media coverage of his talk, however, Venter stands god-like on the verge on breathing life into his monstrous creation—already dubbed by the press the "Frankencell." Even the name has an unsettling, nightmarish quality, calculated to instill foreboding and heighten anxiety.

But Venter was not at the meeting to announce the imminent completion of the first artificial cell. In fact, he announced that work on the project has stopped. He is placing this research on hold until he hears back from a group of 20 leading theologians, lawyers, and philosophers, assembled by Arthur Kaplan at the Center for Bioethics at the University of Pennsylvania, who will debate whether the work is morally and ethically acceptable. Such discourse and openness has been noticeably and regrettably lacking in biotechnology. Tackling the societal and ethical issues engendered by research upfront—as Venter is doing in this situation—is an approach that the biotechnology industry at large would do well to follow. It's unfortunate that this admirable attempt at accountability was omitted from many of the "Frankencell" media reports that subsequently appeared.