Rachel's Environment & Health News
#721 - Engineering Humans -- Part 2
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Human beings can be genetically engineered in three ways: by inserting genes into the cells of existing people (somatic cell manipulation, sometimes called "gene therapy"); by trying to copy an existing person (cloning); or by changing the genes of future generations (germline manipulation). Here we will examine serious proposals to modify the human germline to "improve" the human species, or perhaps even to create an entirely new species of humans. Researchers have not yet tried to manipulate the human germline, but proponents would like to convince us all that its a good idea.

Biologist Daniel Koshland of the University of California at Berkeley, a former editor of SCIENCE magazine, is a leading advocate of genetic engineering to improve the human species. Koshland writes, "If we do go ahead with germline engineering, as I think we should, I can't see any possible reason for not allowing enhancement therapy. We are facing monumental problems with the population explosion, environmental pollution, the shortage of fossil fuels, and the serious lack of leadership.... Should we turn our back on new methodologies that might bring us smarter people and better leaders who are more responsible in their lives? It's going to be tricky, but it seems silly to shut our eyes to a new technology like this."[1, pg. 29]

In other words, Koshland is urging us to solve social and environmental problems by redesigning our children. Unfortunately, there is zero evidence that gene manipulation can instill "leadership" or "responsibility" in babies. As for making people smarter, even if it were possible there is no reason to think "smarter" people are the solution to humanity's problems. Many of the problems we face were created by some of the smartest people in the world -- and were then loosed upon the world with little consideration of the consequences.

The problems of technology and leadership today can both be traced to a common source: decisions made by elites who don't engage the people affected by their decisions. What we need is not "smarter" people groomed to impose decisions on the rest of us, as happens now; instead, we need more people with common sense participating in decisions. In other words, we need to make decisions in new ways, with the democratic participation of everyone who will be affected.[2]

Some of Koshland's colleagues paint an even more extreme picture of what genetic engineering could mean for the human race. Lee Silver, a molecular biologist at Princeton University, writes about future scenarios in which parents could design embryos to suit their preferences. He suggests the human race could eventually divide into two species, one with a normal set of genes and the other with various expensive genetic "improvements." The new race of improved humans might be unable to mate with ordinary humans due to genetic incompatibility, Silver says.[3] In the future that Silver envisions, the divide between rich and poor would be permanently coded into our cells, much as Aldous Huxley foretold in BRAVE NEW WORLD in 1932.

W. French Anderson of the University of Southern California School of Medicine wants to try engineering the somatic cells of fetuses as they develop in the womb. Anderson hopes this might be a way to "cure" inherited diseases;[4] other researchers even hope to get rid of unwanted traits such as high cholesterol levels.[5] Almost all attempts to cure disease in adults or children through somatic cell manipulation have failed, but some proponents say a consistent record of failure is no reason to delay experiments on fetuses.[6]

Anderson and others say they plan to leave the future sperm or egg cells of a fetus intact, but they acknowledge they could alter sperm and eggs by accident, thus producing changes that could be inherited by future generations.[4]

It seems unlikely that any of this will ever succeed. Genes usually do not control just one characteristic, so changing a gene is likely to have multiple consequences. Furthermore, a single characteristic may be controlled by several genes. These facts make it seem unlikely that gene therapy or germline engineering of humans will ever produce the desired results without creating new problems.

Researchers recently introduced a gene for a fluorescent (glowing) protein into the cells of fourteen fetal monkeys,[7] but the monkeys' cells stopped producing the fluorescent protein a few months after birth; evidently, they shut off the foreign genes as they matured.[7, pg. 134]

We know from plant experiments that foreign genes often behave unpredictably. In one case, petunias were engineered to produce salmon-red flowers. When the weather turned unusually hot, the engineered petunias began producing flowers of other colors. Apparently the stress of high temperatures caused the plants, unpredictably, to shut down some of the foreign genes.[8] If monkeys shut off foreign genes as they mature, and if plants shut down foreign genes in response to stress, should we expect foreign genes in humans to behave differently?

When researchers genetically manipulate any plant or animal --whether they are making clones or adding genes to existing embryos -- they routinely produce organisms that are abnormal in disastrous ways. It can take thousands of tries before genetic engineers get the results they want in an engineered plant, and many engineered plants are discarded because they are deformed or display an unintended new feature.[9, pg. 3] When researchers clone animals or manipulate the cells of animal embryos, the resulting creatures often have severe defects.[10]

Germline engineering in animals, as in plants, can lead to insertional mutation a change in gene function caused by a foreign gene inserted into the middle of an existing gene. (See REHN #716.) In one case, scientists created several generations of mice with deformities resulting from an insertional mutation.[11] If researchers introduced an insertional mutation into a human embryo, they would create a baby with a defect that could become obvious at birth, later in life, or only when the victim of the experiment grew up and had children.

In general, problems that have arisen in genetic engineering experiments on plants and animals can be expected to appear in experiments on humans. But theres an important difference: Genetic engineers who work with plants or rodents can breed multiple generations to test whether an inserted gene performs as expected in a laboratory setting. With humans, we cannot breed test generations in a lab.

Some people still argue that somatic cell manipulation on consenting individuals could be justified to treat serious disease, if it could ever be shown to work the way it is supposed to. Germline manipulation, in contrast, can never be justified as a medical treatment, unless we redefine medicine to include "curing" people who have not yet been conceived. For this and other reasons, many people consider germline manipulation wholly unacceptable. Altering the genes of future generations would amount to a dangerous experiment carried out on subjects who have no choice about participating. The United Nations' International Covenant on Civil and Political Rights, which the U.S. ratified in 1992, prohibits medical or scientific experimentation on individuals who have not consented freely to participate.[12]

Whether they want to insert foreign genes into adult cells, "enhance" an embryo, or redesign a fetus, proponents of human engineering often talk as though genes were the key to controlling health and disease. In fact, few diseases are strictly determined by genes. In the vast majority of cases, disease is produced or prevented through interactions between genes and our social and physical environments.[13] For example, certain genetic mutations may increase the likelihood of breast cancer, but women with these mutations will not necessarily develop breast cancer. Furthermore,

90% of women who do develop breast cancer do not have a family history of the disease and therefore probably did not develop it because of a gene.[14, pgs. 168-170]

Focusing on the genetic elements of sickness and health diverts attention away from the social and environmental causes of disease and makes it easy to blame preventable illnesses on "bad genes." If our goal is healthier, smarter, or otherwise "improved" future generations, there are obvious ways to achieve that goal, such as protecting pregnant women and their babies from toxic exposures and making sure all women have opportunities for good nutrition and health care during pregnancy.

To learn more or to join the effort to prevent dangerous and unethical genetic engineering of humans, contact:

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** Council for Responsible Genetics (Cambridge, Mass.): (617) 868-0870; E-mail crg@gene-watch.org; web: http://www.gene-watch.org

** Human Genetics Alert: web: http://www.users.globalnet.co.uk/~cahge/

--Rachel Massey and Peter Montague

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[1] Gregory Stock and John Campbell, editors, ENGINEERING THE HUMAN GERMLINE: AN EXPLORATION OF THE SCIENCE AND ETHICS OF ALTERING THE GENES WE PASS TO OUR CHILDREN [ISBN 0195133021] (N.Y.: Oxford University Press, 2000), pgs. 29, 67-71.

[2] See, for example, Benjamin R. Barber, STRONG DEMOCRACY: PARTICIPATORY POLITICS FOR A NEW AGE [ISBN 0520056167] (Berkeley, Calif.: University of California Press, 1984).

[3] Lee M. Silver, REMAKING EDEN: HOW GENETIC ENGINEERING AND CLONING WILL TRANSFORM THE AMERICAN FAMILY [ISBN 0380792435] (N.Y.: Avon Books, 1998).

[4] Jennifer Couzin, "RAC Confronts in Utero Gene Therapy Proposals," SCIENCE Vol. 282, No. 5386 (October 2, 1998), pg. 27.

[5] Joanna Marchant, "Generation Game," NEW SCIENTIST Vol. 168, no. 2267 (December 2, 2000) pgs. 16-17.

[6] Holm Schneider and Charles Coutelle, "In Utero Gene Therapy: The Case For," NATURE MEDICINE Vol. 5, No. 3 (March 1999), pgs. 256-257.

[7] Alice F. Tarantal and others, "Rhesus Monkey Model for Fetal Gene Transfer: Studies with Retroviral-Based Vector Systems," MOLECULAR THERAPY Vol. 3, No. 2 (February 2001), pgs. 128-138

[8] Peter Meyer and others, "Endogenous and environmental factors influence 35S promoter methylation of a maize A1 gene construct in transgenic petunia and its colour phenotype," MOLECULAR GENES AND GENETICS Vol. 231, no. 3 (Febr. 1992), pgs. 345-352.

[9] Michael K. Hansen, "Genetic Engineering is Not an Extension of Conventional Plant Breeding; How Genetic Engineering Differs from Conventional Breeding, Hybridization, Wide Crosses and Horizontal Gene Transfer," report produced by Consumers Union. Available at http://www.consumersunion.org/food/widecpi200.htm.

[10] Rudolf Jaenisch and Ian Wilmut, "Don't Clone Humans," SCIENCE Vol. 291, No. 5513 (March 30, 2001), pg. 2552. Also see Lorraine E. Young and others, "Large Offspring Syndrome in Cattle and Sheep," REVIEWS OF REPRODUCTION Vol. 3 (September 3, 1998), pgs. 155-163.

[11] Chao-Nan Ting and others, "Insertional Mutation on Mouse Chromosome 18 with Vestibular and Craniofacial Abnormalities," GENETICS Vol. 136, No. 1 (January 1994), pgs. 247-254.

[12] United Nations High Commission for Human Rights, INTERNATIONAL COVENANT ON CIVIL AND POLITICAL RIGHTS (December 16, 1966). Available at http://www.unhchr.ch/html/menu3/b/a_ccpr.htm

[13] David E. Larson, editor, MAYO CLINIC FAMILY HEALTH BOOK [ISBN 0688144780], 2nd Edition (N.Y.: William Morrow, 1996), pg. 42.

[14] Ruth Hubbard and Elijah Wald, EXPLODING THE GENE MYTH: HOW GENETIC INFORMATION IS PRODUCED AND MANIPULATED BY SCIENTISTS, PHYSICIANS, EMPLOYERS, INSURANCE COMPANIES, EDUCATORS, AND LAW ENFORCERS [ISBN 0807004312] (Boston: Beacon Press, 1999).

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