THE CENTER FOR BIOETHICS AND HUMAN DIGNITY

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DIGNITY

THE NEWSLETTER OF THE CENTER FOR BIOETHICS AND HUMAN DIGNITY

Christian perspectives on bioethical challenges, such as end-of-life care, euthanasia, genetic and reproductive technologies, abortion, and the changing face of health care.

HUMAN/ANIMAL TRANSGENICS: WHEN IS A MOUSE NOT A MOUSE?

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Transgenic animals are animals which have had DNA from another species inserted into their genome. The goal of transgenics is to produce a hybrid animal that is able to pass on genetic material from two different species to the next generation. Inserting genes from one species into another species to create a transgenic animal is considered the most powerful technology for modeling disease processes and for determining the mechanisms by which genes are regulated during development. Transgenic animals, also called "bioreactors," allow the effects of various factors on a gene's function to be tested in a whole animal rather than merely in a test tube or cell. By inserting human DNA into an animal such as a mouse, medical researchers are provided with important information which may help them in their efforts to conquer human disease. Transgenic technology has undergone explosive growth in the last decade. A 1989 search of the NIH Computer Retrieval of Information on Scientific Projects (CRISP) database for government-funded human/animal transgenic research revealed only 21 grants–a number which grew exponentially to 1,820 grants by 1999. Today nearly 20% of government-funded research grants go toward underwriting research in transgenics.

Until recently, most transgenic animals were created by inserting just one or two genes from one species into an animal of another species. However, the current trend is to insert more and more human DNA into an animal of another species. Newer techniques using yeast artificial chromosomes (YACs) and bacterial artificial chromosomes (BACs) allow insertions of up to 1/3 of a chromosome to create a transgenic animal. This YAC transgenic technology is currently being employed to create transgenic pigs for the purpose of developing organs for human transplantation (a technique known as "xenotransplantation"). The successful application of these techniques has raised important ethical questions. For example, should there be a limit to the amount of human DNA inserted into an animal? Should such limits be enforced for transgenic research which has great therapeutic benefit for human beings? How would such "therapeutic benefit" be determined?

In Europe, concern over transgenic animals has focused on the breach of species barriers and the violation of species integrity entailed by the creation of such animals. The Bible tells us that God designed procreation so that plants, animals, and humans always reproduce after their own kind or seed. In the biblical view, then, species integrity is defined by God rather than by arbitrary or evolutionary forces. Christians involved in and/or concerned about transgenics should seek to determine whether the creation of a human/animal hybrid violates this biblical notion of species integrity.

The complete fusion of human and animal genomes via the union of sperm and egg from these different species runs

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GENETIC INTERVENTION: ETHICAL CHALLENGES AHEAD

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As scientists continue to race toward their goal of mapping all of the genes in a human being, more and more people are asserting that the repercussions of the genetic revolution will outstrip the effects of the industrial, atomic, and computer revolutions combined. This belief stems from the reality of our newly found ability to deliberately and specifically change the fundamental qualities of a living organism by simply adding to, subtracting from, or rearranging its genetic structure. This power is expected to extend to human beings in ways previously hardly even imagined.

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counter to the sacredness of human life as created in the image of God. Biblically, bestiality (sex between humans and animals) is forbidden and punishable by death. Some might assume that the severity of this penalty was due to the defilement of the physical body or the "heart," rather than to a concern about the creation of viable offspring with the genes of two species. The distinction between physical copulation and the creation of offspring becomes important in transgenic technology involving animals and humans because there no physical copulation occurs; however, the resulting offspring does have genetic material from these different species.

Closer examination of the Bible suggests that Scripture is concerned with more than just the physical defilement associated with sex between a human and an animal. Leviticus 18:23 ends with the phrase "it is confusion." The word confusion *(tebel)* means "in violation of nature or divine order." This word is used in only two contexts: when a woman lies with a beast and when a man lies with his daughter-in-law. The second example could, of course, result in viable offspring. Additionally, the word *raba*–translated in these passages as "mate, gender or lie down"–has the inherent meaning of "copulation" or "breeding." Breeding, too, suggests the potential for offspring. The Bible leave us, then, with the suggestion that by divine order all things should reproduce only after their own kind, and that interspecies mating–especially that of humans with animals–is prohibited.

We must now ask the question whether inserting, for example, an insulin gene from a pig into a human being whose own genes for insulin production are defective would violate the divine order. To address this question, one must first determine if there is a significant difference between genes from diverse species which have the same function. In the field of molecular biology, individual genes are classified primarily by their function. Such a classification highlights the homology, or similarity, of the DNA sequences of genes which have the same function but are from different species. The primacy of function over species may explain why the scientific community in the United States (unlike that in Europe) hasn't felt the need to justify the technique of inserting human genes into animals–a gene would be a gene no matter what species it was obtained from. However, genes coding for the same function may in fact differ in various degrees among species. These interspecies differences can have dramatic effects on the function of a single gene or on the interplay between that gene and other genes. Transgenic animals have shown that although a gene may code for a protein with a particular function in one species, the expression of that protein in a new host species can have a very different effect. In conclusion, a gene is *not* just a gene no matter what species it comes from.

The next question to be asked is whether the insertion of a single human gene into another species could cause observable changes in the resultant transgenic animal. To date, transgenic research has shown that it is unlikely that the insertion of a single gene from one species into an animal of another species would change the animal's phenotype. For example, the insertion of a single human gene into a mouse would not be expected to produce an observable human characteristic. The phenomenon known as pleiotropy (in which one gene and its product controls or codes for more than one trait by turning on or off large numbers of genes) might raise the level of concern that distinctively human characteristics might be expressed, although most scientists regard this as unlikely.

The already widespread marvel at and openness to human/animal transgenic research underscores the need for Christians to engage this up and coming issue now. Although some members of the scientific community propose that transgenic research go forward with few or no restrictions, it appears that Christians have ample reason to pause at such a prospect. However, should Christians speak out against all transgenic research involving the creation of human/animal hybrids? Or, should they approve of such research for therapeutic or other purposes as long as there is not a "substantial" mixing of genetic material between species or "substantial" differences between species are not removed? Can such "substantial" outcomes be adequately defined or their occurrence even predicted in these contexts? If the research is not expected to have therapeutic benefit for the donor or recipient of genetic material, then should not human donors and recipients be limited to consenting adults (thereby excluding children, fetuses, and embryos)?

It is imperative that Christians consider whether–and when–God's design for human and animal reproduction would be violated by the transfer of genes from one species into another. If and when such violation occurs, then the amount of human benefit potentially to be gained is irrelevant. Good ends do not justify any and all means. However, if scenarios exist where such violation does not occur, then careful assessments of potential benefits and harms will be necessary. Wisdom and oversight will be essential lest the temptation to cut ethical corners in the name of human well-being be irresistible. ■