The Cloning Debates and Progress in Biotechnology

The perception by humans of what is doable is itself a great determiner of future events. Thus, the successful sheep cloning experiment leading to “Dolly” by Ian Wilmut and associates at Roslin Institute, Midlothian, UK, compels us to look in the mirror and consider the issue of human cloning. Should it occur, and if not, how should that opposing mandate be managed? If human cloning should have an acceptable role, what is that role and how should it be monitored and supervised?

In the February 27, 1997, issue of Nature, Ian Wilmut et al. reported that they cloned a sheep (which they named “Dolly”) by transferring the nuclear DNA from an adult sheep udder cell into an egg whose DNA had been removed [1]. Their cloning experiments have led to widespread debate on the potential application of this remarkable technique to the cloning of humans. Following the Scottish researchers’ startling report, President Clinton declared his opposition to using this technique to clone humans. He moved swiftly to order that federal funds not be used for such an experiment and asked an independent panel of experts, the National Bioethics Advisory Commission (NBAC), chaired by Princeton University President Harold Shapiro, to report to the White House with recommendations for a national policy on human cloning. According to recommendations by the NBAC, human cloning is likely to become a crime in the US in the near future. The Commission’s main recommendation is to enact federal legislation to prohibit any attempts, whether in a research or a clinical setting, to create a human through somatic cell nuclear transfer cloning.

The concept of genetic manipulation is not new and has been a general practice for more than a century, through practices ranging from selective cross-pollination in plants to artificial insemination in domestic farm animals. Wilmut and his colleagues made 277 attempts before they succeeded with Dolly. Previously, investigators had reported successful cloning in frogs, mice, and cattle [2-5], and 1 week after Wilmut’s report, Don Wolf and colleagues at the Oregon Regional Primate Research Center reported their cloning of two rhesus monkeys by utilizing embryonic cells. The achievement of Wilmut’s team shocked nucleic acid experts, who thought it would be an impossible feat. They believed that the DNA of adult cells could not perform similarly to the DNA formed when a spermatozoa’s genes mingle with those of an ovum.

On July 25, 1997, the Roslin team also reported the production of lambs that contained human genes [6]. Utilizing techniques similar to those they had used in Dolly, they inserted a human gene into the nuclei of sheep cells. These cells were next inserted into the ova of sheep from which the DNA had been removed. The resulting lambs contained the human gene in every cell. In this new procedure the DNA had been inserted into skin fibroblast cells, which are specialized cells, unlike previous procedures in which DNA was introduced into a fertilized ovum. The new lamb has been named “Polly” because she is a Poll Dorset sheep. The goal of this new genetically engineered lamb is for these lambs to produce human proteins necessary for the treatment of human genetic diseases, such as factor VIII for hemophiliacs, cystic fibrosis transmembrane conductance regulator (CFTR) substance for patients with cystic fibrosis, tissue plasminogen activator to induce lysis of acute coronary and cerebral artery thrombi, and human growth factor.

Charles Darwin was frightened when he concluded that humans were not specifically separated from all other animals. Not until 20 years after his discovery did he have the courage to publish his findings, which changed the way humans view life on earth. Wilmut’s amazing investigations have created worldwide fear, misunderstanding, and ethical shock waves. Politicians and a few scientists are proposing legislation to outlaw human cloning [7]. Although the accomplishment of cloning clearly could provide many benefits to medicine and to conservation of endangered species of animals, politicians and a few scientists fear that the cloning procedure will be abused.

The advantages of cloning are numerous. The ability to clone dairy cattle may have a larger impact on the dairy industry than artificial insemination. Cloning might be utilized to produce multiple copies of animals that are especially good at producing meat, milk, or wool. The average cow makes 13,000 pounds (5800 kg) of milk a year. Cloning of cows that are superproducers of milk might result in cows producing 40,000 pounds (18,000 kg) of milk a year.

Wilmut’s recent success in cloning “Polly” represents his main interest in cloning [8]. He believes in cloning animals able to produce proteins that are or may prove to be useful in medicine. Cloned female animals could produce large amounts of various important proteins in their milk, resulting in female animals that serve as living drug factories. Investigators might be able to clone animals affected with human diseases, e.g., cystic fibrosis, and investigate new therapies for the human diseases expressed by these animals.

Another possibility of cloning could be to change the proteins on the cell surface of heart, liver, kidney, or lung, i.e., to produce organs resembling human organs and enhancing the supply of organs for human transplantation. The altered donor organs, e.g., from pigs, would be less subject to rejection by the human recipient. The application of cloning in the propagation of endangered species and conservation of gene pools has been proposed as another important use of the cloning technique [9, 10].

The opponents of cloning have especially focused on banning the cloning of humans [11]. The UK, Australia, Spain, Germany, and Denmark have implemented laws barring human cloning. Opponents of human cloning have cited potential ethical and legal implications. They emphasize that individuals are more than a sum of their genes. A clone of an individual might have a different...
environment and thus might be a different person psychologically and have a different “soul.” Cloning of a human is replication and not procreation.

Morally questionable uses of genetic material transfer and cloning obviously exist. For example, infertility experts might be especially interested in the cloning technique to produce identical twins, triplets, or quadruplets. Parents of a child who has a terminal illness might wish to have a clone of the child to replace the dying child. The old stigma, eugenics, also raises its ugly head if infertile couples wish to use the nuclear transfer techniques to ensure that their “hard-earned” offspring will possess excellent genes. Moral perspectives will differ tremendously in these cases. Judgments about the appropriateness of such uses are outside the realm of science.

Opponents of animal cloning are concerned that cloning will negate genetic diversity of livestock. This also applies to human cloning, which could negate genetic diversity of humans. Cloning creates, by definition, a second class of human, a human with a determined genotype called into existence, however benevolently, at the behest of another. The insulation of selection-of-mate is lost, and the second class is created. Few contrasts could be so clear. Selection-of-mate is so imprecise that, at present, would-be parents have to accept a complete new genome for the sake of including or excluding one or a few traits; cloning, in contrast, is the precise determination of all genes. If we acknowledge that the creation of a second class of humans is unethical, then we preempt any argument that some motivations for human cloning may be acceptable.

The opponents of cloning also fear that biotechnically cloned foods might increase the risk of humans acquiring some malignancies or infections such as “mad cow disease,” a prion spongiform dementia encephalopathy (human Jakob–Creutzfeldt disease).

The technological advances associated with manipulation of genetic materials now permit us to envision replacement of defective genes with “good” genes. Although current progress is not sufficient to make this practical today for human diseases, any efforts to stop such research as a result of cloning hysteria would preclude the development of true cures for many hereditary human diseases. Unreasonable restrictions on the use of human tissues in gene transfer research will have the inevitable consequences of delaying, if not preventing, the development of strategies to combat defective genes.

Wise legislation will enable humankind to realize the benefits of gene transfer technologies without risking the horrors that could arise from misuse of these technologies. Our hope is that such wise legislation is what will be enacted. In our view, the controversy surrounding human cloning must not lead to prohibitions that would advance similar to those described here.

References

Paul L. Wolf*
Department of Pathology
University of California and
Veterans Affairs Medical Centers
200 W. Arbor Drive
San Diego, CA 92103
Fax 619-552-7452

George Liggins
Bacton Assay Systems, Inc.
San Marcos, CA 92069
e-mail docliggins@aol.com

Dan Mercola
Sidney Kimmel Cancer Center
San Diego, CA 92121, and
Center for Molecular Genetics
University of California–San Diego
La Jolla, CA 92093
Fax 619-450-3251

*Author for correspondence.