Cloning discovery will save lives

by Colin M. Lowry

Since scientists at the Roslin Institute in Scotland announced Feb. 24 that they had cloned a sheep, a political fight has erupted around the cloning issue, which is part of a much larger battle—that of whether scientific progress will continue to save lives and increase mankind's power over nature. The cloning discovery has the potential to create new and better treatments for disease, and has challenged some of the fundamental assumptions of modern biology. The hysteria generated in the popular press over the possibility of human cloning, in fact, was designed to shift the emphasis away from the important benefits to medicine, agriculture, and basic research that the discovery will produce. The issue became so hot, that it soon prompted Congressional hearings in both the House and the Senate, as well as review action by the National Bioethics Advisory Commission.

The new cloning technique involves the transfer of the nucleus containing the DNA (the genetic material) from an adult cell, into an egg that has had its DNA removed. (See figure, p. 12.) The resulting embryo is genetically identical to the adult animal from which the nucleus was transferred.

In the procedure developed by Dr. Ian Wilmut and his team at the Roslin Institute, cells are removed from an adult sheep's udder, and grown in culture. The cultured cells are treated chemically so that they exit the growth phase of the cell cycle and enter a quiescent state. This is key to the success of the technique, because putting the adult donor cells into a state of metabolic quiescence makes them very similar to the metabolic condition of an unfertilized egg. It is thought that this will put the donor DNA into a conformation that is likely to respond to those proteins in the egg that direct and regulate genes in development.

The next step in the procedure is to remove the DNA from an unfertilized egg, and then fuse the donor cell nucleus to the egg using a small electric charge. This electric charge starts the cycle of cell division and growth. Once the embryo has grown to an adequate size, it is implanted into a surrogate mother, where it will develop normally.

Scientists have attempted cloning of amphibians and mammals for years, but no one had previously succeeded in producing offspring that could fully develop. The breakthrough in cloning has challenged two fundamental assumptions in biology. The first is that only germ cells, sperm and egg, can participate in forming a new individual. Second, it was previously believed that an adult's cells that are terminally differentiated have had their DNA conformation permanently changed, making them unable to re-direct the developmental program necessary for producing a new individual. The cloning success has shown that any changes to the DNA conformation are reversible, which will open up many new approaches to gene regulation. This may mean that a differentated cell, such as a liver cell, can be re-programmed to return to an embryonic state, and then grow and differentiate into new liver cells to repair damage.

Many benefits

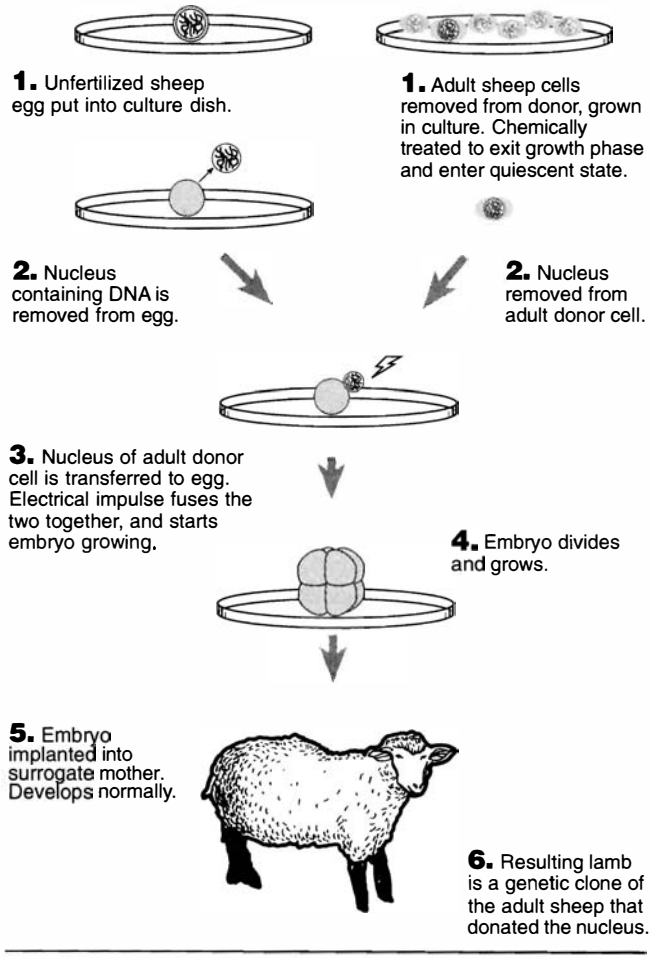
Dr. Harold Varmus, director of the National Institutes of Health, discussed the possibilities of tissue regeneration and repair in testimony before the Senate Subcommittee on Public Health and Safety, March 12. He said that the understanding of gene regulation in human development may make it possible to de-differentiate cells, correct genetic defects, and then direct them to grow back into their specialized type. This would have a huge impact on the treatment of injury and disease.

One area where the cloning technology will have a large impact is in the production of human therapeutic proteins and drugs. In his testimony, Dr. Ian Wilmut told the Senate committee, "The reason why we were trying to develop this technique was because we believe that it will offer important new opportunities for the production of health care products for treating different diseases." For example, many human proteins for therapeutic use, such as insulin for diabetics, are now produced in animals that have human genes integrated into their genomes (known as transgenic animals). The procedure for making the transgenic animals now relies on injecting the desired genes into the nucleus of the animal embryo cells. This procedure is very inefficient, as only a small percentage of the embryos have the gene correctly integrated into their genome. Often the production of the protein corresponding to the integrated gene is not expressed correctly in the animal. The new cloning technology has the potential to increase the efficiency, accuracy, and speed of creating transgenic animals that produce human proteins such as insulin and blood-clotting factors.

The new technique also offers the opportunity to make genetic changes in farm animals. This would make it possible to produce animal models of human genetic diseases. For example, the Roslin Institute is working on developing drugs

Dolly, the cloned ewe, with her surrogate mother.

How cloning works



to treat cystic fibrosis. A transgenic animal could be made that has the genetic defect found in cystic fibrosis, and treatments for the disease could be tested directly on the transgenic animal. The Roslin Institute has already made transgenic sheep that secrete a therapeutic protein in their milk that is used to treat cystic fibrosis.

The cloning technique could also allow the study of the function of specific genes in development. For example, biologists currently have to go through a difficult procedure to knock out a gene in mice, and then look for its effects in development. We already have powerful and efficient techniques for introducing new genes to cells grown in culture, so one can select for the cells expressing the new gene, and directly clone an animal from them. This new procedure would make knock-out experiments easier, and also allow for genes to be altered, and the results in development or function of an animal to be studied. This could lead to the creation of livestock, such as cows, that produce more milk, or cattle that are more resistant to certain diseases.

Dr. John Wallwork, head of the transplant unit at Papworth Hospital in England, spoke before the Senate committee about the application of using transgenic animals as sources of organs for transplantation into humans. Dr. Wallwork's group has created pigs with human surface proteins expressed on their organs, which are designed to reduce the human immune response in patients who receive these organs. His group has done transplants from transgenic pigs into primates with very little rejection by the immune system, which could open the possibility of doing human trials in the near future.

There is a severe shortage of suitable donor organs available, which results in thousands dying each year while waiting for an organ transplant. From 1988 to 1995, the increase of deaths of people on waiting lists for organs increased by 128%. Dr. Wallwork stated that the cloning technology is the future for transplants, and that its application could produce enough transgenic animal organs to save the life of every patient who now dies while on a waiting list for human organs. It will also break the existing cycle of having to wait for a healthy person to die in order to get an organ to save a sick person. This will also decrease the prevalence of "black market" organs and the murder of people for their organs.

Senate hearings on legislation

Sen. Bill Frist (R-Tenn.), the chairman of the Subcommittee on Public Health and Safety, had called the committee hearings to address the opportunities the cloning discovery has for medicine, agriculture, and research. (See table, p. 13.) The debate on whether there should be any legislative action on the issue of human cloning was a focus of the Senators on the committee. Sen. Frist said that while most people agreed that we should not be undertaking research for the purpose of cloning people, his concern was, "Can you write a bill so narrow that you don't jeopardize the very good research that

has the potential for saving millions of lives that has to do with genetic-type procedures? If we're going to endanger that research in any way," he said, "I am opposed to that legislation."

Frist, who is a heart transplant surgeon, compared today's response to cloning to the public reaction to the first heart transplants in the 1960s. "When we would cut out a heart from one human being and put it into another, it was considered unethical, not scientific, impossible, tyrannical, playing God," he said. "This is not that dissimilar, in that we have a breakthrough in science today which we need to understand."

Most of the scientific community opposes human cloning on moral grounds, but scientists are also wary of broad legislation in this area that could damage research. Dr. Wilmut told the Senate committee, "We are very concerned that in prohibiting any potential misuse of this technology, society does not lose the opportunity to develop new treatments." Dr. Varmus echoed this view, saying that he "hopes legislation is not necessary." Varmus reminded the Senators that scientific advances in recombinant DNA technology in the late 1970s were met with similar concerns about misuse, but no legislation was adopted, and medicine has benefitted accordingly.

Bills banning human cloning research have been introduced in the Senate and the House, by Sen. Christopher S. Bond (R-Mo.) and Rep. Vernon J. Ehlers (R-Mich.), respectively, but these bills are too broad and are not supported by scientists. Essentially, both ban federal funds for human cloning research, and make such research illegal in the United States. Dr. Varmus commented on the bills, at the hearings, saying that we are "not in a crisis," and human cloning was not going to happen overnight. It is not known if humans could be cloned using the new technique, he said, and he cautioned the Senators to avoid rushing to legislate on this issue.

The scare stories

Most of the public misunderstanding about cloning stems from the belief that clones of people would be exact replicas, having the same personality and intelligence. This view is the source of the many scare stories about human cloning, such as creating clones of a Hitler or any other despicable personality. Professor Karen Rothenberg, director of the Law and Healthcare Program at the University of Maryland, identified this misunderstanding of cloning as the result of "a reductionist genetic myopia." "We know that identical twins are distinct individuals," she said, and the same would be true of any cloned person. Rothenberg pointed out that you can't "bring someone back" through cloning.

Sen. Tom Harkin (D-Iowa) shook up the committee hearings by stating flatly that he opposed all legislative actions banning human cloning. "What utter nonsense to think we can throw up our hands and say 'stop,'" Harkin said. He attacked attempts to do so as limiting science. "I don't think there are any limits to human knowledge," Harkin said: "Human cloning will happen in my lifetime. I don't fear it at all. I welcome it." He praised Dr. Wilmut as a trailblazer for science, and insisted that the role of the government was to support basic research, not place limits on it.

The beauty of basic research, Harkin said, was that you didn't know what kind of beneficial application it would have when you started out, and that it was human nature to explore the unknown. Dr. Wilmut responded to Harkin by saying that he agreed that there should not be limits to basic research, but that he hoped that human cloning would not take place, and that it was up to society to decide whether we want to go in this direction.

The opposition

The policy issue of genetic engineering is more complex than a pro- or anti-science battle. Even some of the proponents of genetic technologies would limit their application for the public good by restrictive controls in the name of proprietary rights—"private property." This has happened especially with the agricultural applications of genetic engineering, where, instead of allowing the technological applications to provide more food for hungry nations, a conglomerate or

Biotechnology products, benefits already in use

	Genetically engineered feature	Benefit
	Crops	
Rice	reduced disease susceptibility	higher yield
Corn	reduced disease susceptibility	higher yield
Corn	resists natural pests	less pesticide need
Tomato	reduced bruisability	better durability
Cotton	reduced disease susceptibility	higher yield
	Transgenic animals for food	
Pig	decreased E. coli susceptibility	reduced human infection
Pig	decreased salmonella susceptibility	reduced infection for humans and animals
Pig	increased lean mass	higher-quality meat product
Cow	increased milk production	reduced cost of production
	Transgenic animals for production of medical products	
Goat	antithrombin 3	anti-blood-clot drug
Pig	human insulin	diabetes treatment
Goat	human blood-clotting factor	hemophilia treatment
Sheep	tissue plasminogen activator	wound healing
Sheep	proteinase inhibitor	cystic fibrosis treatment
Cow	prolactin	dietary supplement, AIDS treatment
Goat	angiogenin	used in cancer treatment
Goat	beta interferon	anti-cancer, and multiple sclerosis treatment

Note that many of these biotechnology advances in agriculture are not used as widely as they could be because of current proprietary policies.

At the Senate hearing on cloning March 12. From left: Sen. Tom Harkin; Sen. Bill Frist; Dr. Ian Wilmut, developer of sheep cloning technique; and Sen. Ted Kennedy.

cartel tightly controls the applications, driven by the aim of profit, even at the expense of the public good. (The question of leaving technology advances and medical research solely in the hands of such so-called "market forces," will be the topic of a future article.) Ironically, Senator Frist is associated with one of the largest international for-profit hospital chains, which, in the course of "privatizing" for profit, has shut down the medical research training and applications divisions of the hospitals taken over.

It is ironic that the environmentalist groups that claim to be protecting people, represent the most organized opposition to the cloning discovery that will save lives. In fact, green groups and their spokesmen, such as Jeremy Rifkin, have attacked the cloning discovery as a terrible thing that will lead to a "counterfeit culture." Rifkin, et al., often working with religious fundamentalists, have protested against every advance in biotechnology for the past 25 years. Recently, the enviro-terrorist group Greenpeace has been involved in attacks against high-yield genetically engineered crops, and in Austria, Greenpeace has pressured the government to ban the import of genetically engineered corn. Their scare campaign included protests against supermarkets that carried any products that contained genetically engineered soybeans, which led to some supermarket chains deciding not to carry these products—a decision based directly on lies provided by Greenpeace.

The anti-science green groups have opposed any scientific discovery that will save human lives and increase population, which includes all medical research and high-yield agriculture products. The most violent leaders of the attack on medical research are the "animal rights" terrorist groups, which have burned down research labs and murdered scientists. In fact, the Roslin Institute in Scotland, where the cloning research is being carried out, was the victim of a terrorist attack six years ago, when two of its research labs were burned down.

Concerns over the use of the cloning technology have led some people to bring up the evil legacy of the Nazi eugenics movement, which aimed at weeding out of existence people defined as undesirables or "useless eaters." It is important here to understand the distinction between the policy question of the use of science, and the fact that evil people might come into control of such a technology. The point is that to fight the evil application of a technology, you must fight the evil people, not fight the technology, or ban it. In fact, to be duped into opposing the scientific discovery would be helping the very evil purposes to which the person objects, by denying society the beneficial use of that discovery.

In the case of the cloning technology, it is the desire of the anti-science green groups that the hysteria around this issue will pressure people to ban a technology which will, no doubt, save lives and increase population. These groups hope to dupe supposedly moral people by using fear to force them into making an irrational decision to ban scientific progress.

When bioethicist George Annas, of Boston University, compared the cloned sheep Dolly to Frankenstein, he was chastised by Sen. Harkin for raising an image that only instills fear. Many fears of creating deformed monsters through cloning reflect the lack of understanding that living processes are bounded by a lawful ordering, which makes such aberrant creations impossible. The most exciting thing about the cloning discovery is that it increases our understanding of living processes, and provides many wonderful applications in medicine and agriculture.