Double Trouble: To Clone or Not to Clone?

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If the American Revolutionary War featured the "shot heard 'round the world," then the news from Edinburgh last month certainly created tremors felt by scientists across the globe: a mammalian clone had actually been created. This was the stuff of which, only several decades ago, science fiction was made; but what once existed only in the minds of creative authors has now been brought into actuality by the hands of creative geneticists. But was this the next step in an ever-progressing quest for knowledge, or has a Pandora's box been opened--has a line been crossed from which there is no return? Now that Dr. Ian Wilmut has shown the world that cloning *is* possible, the way has been paved "for any biochemist to take mammalian cloning to another height: by cloning a human. We now stand poised on the precipice of heretofore uncharted territory --not only does science have the ability to do what has never been done before, but worldwide legislatures are now scrambling to enact regulations to control what is still essentially unknown. As such, we have a moral obligation to scrutinize carefully the potential risks and benefits of pursuing this technology. Our analysis must address not only the nature of the present discovery, but it must also examine the potential future effects. An in-depth examination of genetic research reveals that, if approached in an ethically responsible manner, the benefits of this research substantially outweigh possible negatives.

We will take this investigation one step further by examining the implications of cloning technology on business ethics. This analysis will demonstrate that the genetic industry can be expected to operate in a morally upstanding manner; in those areas in which ethical concerns are of particular importance, federal regulations can ensure ethical conduct. In short, although people seem to have an initial hesitation to embrace this technology, cloning techniques and related genetic study stand to deliver immense good to the social population as a whole.

By modern chemistry standards, the researchers at Scotland's Roslin Institute did not employ any groundbreaking scientific techniques, but it was their results that were so extraordinary.[1] The central dogma of biochemistry has traditionally held that embryonic cells can eventually turn into adult cells, but that the reverse is not true. That is, a cell in a developing fetus has the potential to eventually become, or "differentiate into" a heart cell, a lung cell, an eye cell, or any other type of cell. But once a cell is differentiated, that is, once it has been "programmed" to be a part of a particular organ, it was believed that this program was fixed.[2] However, Dr. Wilmut was able to take an egg cell from one sheep and implant its DNA into a cell from the udder of a ewe (which has already had its genetic material removed). This udder cell, remarkably, was able to differentiate once more, exhibiting characteristics never before associated with an adult cell. The result was that

[1] "Little Lamb, Who Made Thee?" *Newsweek,* March 10, 1997, pp 53-60, Vol CXXIX.
[2] "A Clone by Any Other Name is Still an Ethical Concern," *Journal of the American Medical Association,* February 2,1997, p. 331, v. 271, #5.

the altered cell actually contained DNA from the donor sheep, so that the resulting egg was genetically identical to the "mother sheep." Hence, Dolly was born, the first clone ever produced.[1]

This entire story sounds like something out of *Jurassic Park*, a movie wherein DNA was recovered from mosquitoes that had bitten dinosaurs. This DNA was then cultured, re-engineered, placed in an egg cell, and incubated until a real dinosaur actually hatched. It appears, then, that reality is mirroring fiction. But there is one significant difference: whereas the dinosaurs were created using private funds, Dr. Wilmut and his colleagues rely on capital provided by stockholders. As such, they have an inherent obligation to ensure that their activities can ultimately provide a fair and equitable return on this investment. Hence, financial concerns must also be considered.

The financial consequences can potentially be staggering. PPL Therapeutics, the small Edinburgh-based company which provided 30% of the funding to create Dolly, is already anticipating a $1 billion market for itself early in the next millennium.[2] The source of these revenues is primarily from a single area: genetically engineered cows and sheep whose milk contains human proteins.[3]

At present, premature babies often cannot nurse, yet nursing is a vital means by which necessary proteins and amino acids are passed from the mother to infant. An infant deprived of its mother's milk must then rely on dairy milk, which is deficient in these proteins. But PPL has already created Rosie, a cow whose milk contains the human protein alpha-lactalbumin.[4] This protein contains all of the essential amino acids a newborn requires, and can dramatically improve survival rates for premature infants. However, the genetic research necessary to create Rosie was a long and expensive process in which genes were carefully studied and modified, and then implanted into egg cells. This process is not really cloning, since clones share identical DNA genomes (the entire length of DNA), and not just identical genes (specific active segments of DNA). The final result is a cow whose internal cellular machinery has been slightly modified in such a way that is, as far as we have determined, harmless to the cow, yet dramatically beneficial to humans. In fact, powdered forms of this milk will be sent to underdeveloped countries in which malnutrition is a significant concern.[5]

This technology can be extended in numerous ways; for example, PPL is now attempting to engineer sheep with strong and fine wool. Approximately 5-10% of a sheep population produced by natural reproduction feature this wool, but it may soon be possible to create sheep with specific genes for this wool, eliminating a large degree of uncertainty. (Selective breeding, that is, mating two sheep who both share the same desired trait, typically produces offspring with that trait about 75% of the time; genetic manipulation can raise that figure to 99.9% certainty.[6]

People typically seem hesitant to embrace this type of technology, fearing that somehow the entire process is "unnatural." However, such genetic manipulation has been commonplace for almost two decades. The most prevalent forms are with corn plants that have been genetically modified to be resistant to temperature extremes, insects, and pesticides. The actual corn that is consumed is indistinguishable from non-altered corn in terms of taste, texture, and nutritious value. So from a business point of view, this type of gene modification makes perfect sense: output is increased, wastage is minimized, and labor costs decrease (less effort is required to separate "good" and "bad" corn). The recognized cost savings can then be passed on to consumers, and the additional output

[1] http:/ /www .newscientist.com/clone/giantleap.html
[2] "Panel Urges Cloning Ethics Board," *Science,* January 3,1997, p. 22, v. 275, #5296.
[3] "Narcissus Cloned," *America,* February 12,1997, p. 15, v. 170, #5.
[4] "Will There Ever Be Another You?" *Time,* pp. 60-68, March 10, 1997, v. 149, #10.
[5] *Ibid.*
[6] "Cloning Human Embryos," *Science News,* p. 145, February 5, 1996, V, 145, #6.

can be exported.[1] Extending this technology, then, from crops to animals, does not necessarily create significant moral or ethical dilemmas; the inherent being of the animal in question is not altered, but a single desirable output is amplified.

Thus, the next logical extension is genetic modification on humans. Once more, people may recoil, but again, genetic research on humans is already taking place. Genetic sequences which predispose for certain hereditary diseases are being elucidated; one result is that, through amniocentesis, 90% of babies who have Trisomy-21 (Down's Syndrome), are selectively aborted.[2] Our knowledge of genetic interaction is already being used to modify the reproductive process, and again, social acceptance has already been gained. One may question the ethical implications of aborting a fetus that does not necessarily conform to societal definitions of "normal," but this argument is beyond the scope of a cloning argument.

So now we turn to this latest technology, featuring the first clone ever witnessed. Interestingly, the word "clone" comes from a Greek word that means "twig" and refers to the practice of slicing off a piece of a plant and rooting it elsewhere.[3] The new plant is genetically identical to the former, just as Dolly's genes are carbon-copies of her "mother's" genes. Modifying plants, animals, and even humans, is somewhat commonplace, and is even accepted in scientific, business, and social communities. But cloning raises a new set of ethical questions, which shall be discussed now.

First, we must consider whether any feasible benefits can arise from this type of technology. Clearly, the potential medical benefits are substantial. For example, as discussed above, what was so remarkable about Dolly's "conception" is that an adult cell, whose programming was believed to be fixed once the cell had differentiated, mimicked an embryo cell again; an adult udder cell divided exponentially and eventually gave rise to eye cells, brain cells, etc. So if an adult cell can produce new structures in a sheep, should this not be possible in humans? Currently, a person who suffers a spinal cord injury is paralyzed permanently. Perhaps spinal cord cells which no longer divide and reproduce, can be compelled to divide again, thus regenerating the injured segment, returning mobility to the victim. Similarly, heart or brain tissue that may be damaged during a heart attack or stroke can be regenerated using this technology. Interestingly, the study of cloning could also offer insights into the nature of cancer cells, which are destructive in that they revert back to the embryonic stage and multiply uncontrollably. So clearly, human medical benefits are significant indeed.

Furthermore, cloning offers infertile couples the opportunity to have a child without resorting to drugs or surrogacy. In this regard, cloning is no differently ethically than artificial insemination, in that the actual "conception" does not occur in the traditional sense. Both techniques are mere genetic manipulations; the only difference lies in the amount of common genetic material between parent and offspring. If one is ethically accepted, the other should be as well. Indeed, there is little real cause for alarm, for reasons that shall be clarified shortly.

Finally, the cloning of animals has another possible benefit beyond just to dairy or clothing industries. Only a small piece of tissue is required to create a clone; as such, we have before us the capability of propagating endangered species. Although some may say that this involves with Nature, and is tantamount to "playing God," again, it is already common practice to encourage mating between members of an endangered species.

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[1] http://www.newscientist.com/clone/smallstep.htm1
[2] *Ibid.*
[3] "The Biotech Industry," *Business Week*, pp. 79-87, March 10, 1997.

However, this technique relies on a certain degree of chance that conception will be successful. But we can clone an individual cell, implant it into a surrogate mother, and she will carry it to term just as if it had been conceived naturally. In all likelihood, the "mother" will treat the offspring no differently than if it were the product of standard mating.[1] Consequently, we can ensure the survival of species whose long-term outlook is presently bleak.

Clearly, the benefits to such genetic research into cloning techniques are many. However, as with many new scientific breakthroughs, the potential for misuse is a legitimate concern. This issue is no exception. The first concern that bioethicists raise is the artificial constraint placed on natural evolution. Currently, reproduction involves the combination of two separate sets of genetic information, to produce offspring with a blend of unique characteristics. Natural selection encourages survival of the fittest offspring, while the weaker descendants die, eliminating less-than-optimal genes from the gene pool. If we were to interrupt this process by merely cloning existing cells, we would be limiting the evolutionary process. However, PPL has already considered this concern. Their strategy takes into account the benefit of gene combination as follows. Recalling Rosie, the cow that was genetically altered to produce protein-enhanced milk, the expense in 'creating' a cow like that approached an expensive $1.3 million. More Rosies could be produced at similar expense using the same process of genetic modification. However, if PPL instead clones cells from Rosie, they would obtain virtual carbon-copies of Rosie, each with the same output of enhanced milk. A number of these cows would be cloned, creating a small herd. The cows in this herd would then be allowed to procreate among themselves, and with other select cows (to provide genetic diversity), yielding a large herd with tremendous milk-producing capabilities, at far less cost (probably somewhere around $250,000).[2] Again, these savings can be passed on to consumers, a decision that makes sound business sense. Not only would PPL save money, but they would effectively permit natural selection to continue in a more controlled setting.

Critics of this technology also tend to exhibit a strong Luddite fear of this technology; however, all new scientific breakthroughs are accompanied by vocal opposition by those who do not fully understand the field. Just as Galileo, Copernicus, and Darwin were initially denigrated for their contributions, so too does cloning inspire a very real, and not wholly unjustified, fear. However, a rational inquiry into the realistic applications of cloning can effectively allay these fears.

For example, one fear is that clones will be used as "organ banks," to be harvested at our will. Suggestions have been put forth that clones can be created to be perfect organ donors, from whom chances of transplantation rejection are minimal. However, this is financially infeasible, if nothing else. Organ transplantation is a very precise and delicate operation, and the organs only remain viable outside the body for periods averaging several hours. As such, a brain-dead clone created just as a donor would have to be kept alive artificially for years, if not decades, until its organs were needed. Furthermore, if a clone were created once a need was identified, the clone would still have to develop for nine months before birth, and it would need to be several years old before it could possible donate any organs; this lengthy timeframe makes the application of clones as mere organ donors completely impractical, and in fact realistically impossible. 14x

Another common fear expressed by critics is that some ruthless dictator may seize this technology for evil purposes--that is, we may potentially have an army of Saddam Husseins or Adolf Hitlers. However, this argument discounts the tremendous influence which environment plays on psychological development. A clone would share the identical genome as his donor, but not necessarily the same psychological makeup. For example, Wolfgang Amadeus Mozart grew up

[1] *Ibid.*
[2] http://www.newscientist.com/clone/bioethics.html

with strong musical influences from his father and sister; Mozart the composer apparently had inherent musical talent, but he was also the product of the sum of experiences that he had in the 1800's, with that particular mother and father, teacher, and so on. Though we could conceivably create agenetic copy of Mozart, we would likely never see the same musical aptitude. So, too, would a Hitler, who was molded by his experiences in World War I, in jail, etc., not yield a clone with an identical personality. Therefore, these fears are also realistically unfounded.

Further concerns involve the possibility that clones will be created as slaves, or as an army, or as any type of second-class humans. A clone would be no less human than the rest of us, and would be equally deserving of the rights inherent to all. To reiterate a previous point, there would essentially be no difference between a child that was created as a clone and a child that was conceived as a test-tube baby, and the treatment of any such progeny must be consistent with treatment of any other human.

Perhaps the most significant concern, though, is that this technology could be misused, that we are interfering with Nature's processes. Inherently, this is true, but international precedent suggests that we can limit negative effects. Canada has already created a substantial list of regulations regarding those processes that are permitted and those that are illegal. For example, cloning of humans is currently illegal, as are experiments to combine genomes of animals and humans. Such restrictions can be closely monitored by agencies such as the FDA and independent bioethics groups.

In short, history teaches us that people are eager to ban ideas which they fear or do not comprehend. However, such a ban merely encourages scientists to conduct their work in private, and to not announce their results. A character in *Jurassic Park* said, "You were so concerned with whether you *could* do this, that you never stopped to ask whether you *should* do this." In this case, all evidence suggests that indeed we should go forth. The potential medical benefits are tremendous; but as with any revolutionary technology, the capacity for misuse is cause for genuine concern. The Clinton Administration has already empowered a commission to look into the ethical concerns of cloning, with results expected in the summer of 1997. Regulation (though no outright ban on research) has proven successful in other countries; the US would be wise to follow suit.

From a business point of view, PPL, and other companies of its ilk, are justified from both an ethical and a financial position. Not only do they stand to benefit a significant proportion of the worldwide population, but they are creating value for their shareholders. The ethical concerns arise more from the private sector, for example, if a family wishes to clone a loved one out of bereavement and grief, or if a person wishes to clone himself. These scenarios are outside the business scope, yet can still be regulated by the government. Ultimately, though, as with any new technology, the level of ethical consideration is only a reflection of the moral standards of they who control the technology. A worldwide commission of governmental agencies and biogeneticists must be empowered to create a set of mutually agreed upon rules to limit the potential for misuse; however, we cannot allow the threat of several mavericks rob us of technology that has the potential to be a boon to literally billions of people around the world.