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**ESSAYS ON SCIENCE AND SOCIETY:
Intimations of Immortality**

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Is it simply a design fault that we age and die? If cells were not programmed to age; if the telomeres, which govern the number of times a cell divides, did not shorten with each division; if our bodies could repair damage due to disease and aging, we would live much longer and healthier lives. New research now allows a glimpse into a world in which aging--and even death--may no longer be inevitable. Cloned human embryonic stem cells, appropriately reprogrammed, might be used for constant regeneration of organs and tissue. Injections of growth factors might put the body into a state of constant renewal. We may be able to switch off the genes in the early embryo that trigger aging, rendering it "immortal" (but not invulnerable). We do not know when, or even if, such techniques could be developed and made safe, but some scientists believe it is possible.

These scientific advances could lead to significantly extended life-spans, well beyond the maximum natural age of about 120 years. The development of these technologies may be far in the future, but the moral and social issues raised by them should be discussed now. Once a technology has been developed, it may be difficult to stop or control. Equally, fears provoked by technological developments may prove unfounded; acting precipitately on those fears may cut us off from real benefits. Scanning future horizons will enable us to choose and prepare for the futures that we want, or arm us against futures that, while undesired, we cannot prevent.

The technology required to enable extended life-spans is likely to be expensive. Increased life expectancy would therefore be confined, at least initially, to a small minority of the population even in technologically advanced countries. Globally, the divide between high-income and low-income countries would increase. Populations with increased life-spans would be unlike our aging populations. The new "immortals" would neither be old, nor frail, nor necessarily retired. We have, however, learned that ageism is a form of discrimination, and this may make it more difficult to resist the pressure for longevity. We thus face the prospect of "mortals" and "immortals" existing alongside one another. Such parallel populations seem inherently undesirable, but it is not clear that we could, or should, do anything to prevent such a prospect for reasons of justice or morality. If increased life expectancy is a good, should we deny palpable goods to some people because we cannot provide them for everyone? We do not refuse kidney transplants to some patients because we cannot provide them for all, nor do we regard ourselves as

wicked because we perform many such transplants, while low-income countries perform few or none at all.

Would substantially increased life expectancy be a benefit? Some people regard the prospect of "immortality" with distaste or even horror; others desire it above all else. Most people fear death, and the prospect of personal extended life-span is likely to be welcomed. But it is one thing to contemplate our own "immortality," quite another to contemplate a world in which increasing numbers of people live indefinitely, and in which future children have to compete with previous generations for jobs, space, and everything else.

Such a prospect may make "immortality" seem unattractive, but we should remember that it is connected with preventing or curing a whole range of serious diseases. It is one thing to ask whether we should increase people's life-spans, and to answer no; it is quite another to ask whether we should make people immune to heart disease, cancer, dementia, and to decide that we should not. It might thus be appropriate to think of "immortality" as the, possibly unwanted, side effect of treating or preventing debilitating illness.

There are numerous reasons why we should not contemplate one everlasting generation but be in favor of the regular creation of new human individuals--such as the desire to procreate, the pleasures of having and rearing children, the advantages of fresh people and fresh ideas, and the possibility of continued evolution or at least development. If these reasons are powerful, we might be facing a future in which the most ethical course is a sort of generational cleansing. This would involve deciding collectively how long it is reasonable for people to live in each generation, and trying to ensure that as many as possible live healthy lives of that length. We would then have to ensure that, having lived a fair inning, they died--either by suicide or euthanasia, or by programming cells to switch the aging process on again after a certain time--to make way for future generations.

This might seem desirable, but it is difficult to imagine how it could be enforced, at least if our time-honored ethical principles remain unreformed. How could a society resolve deliberately to curtail healthy life, while maintaining a commitment to the sanctity of life? The contemplation of making sure that people who wish to go on living cannot do so is terrible indeed.

Faced with this problem, society might be tempted to offer people life-prolonging therapies only on condition that they did not reproduce, except perhaps posthumously, or that they agreed if they did reproduce to forfeit their right to subsequent therapies. However, reproductive liberty is a powerful right protected by international conventions. It would be difficult to justify curtailing it, and even more difficult to police any curtailment.

It is unlikely that we can stop the progression to increased life-spans and even "immortality," and it is doubtful that we can produce coherent ethical objections. We should start thinking now about how we can live decently and creatively with the prospect of such lives.

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Stem Cells: Golden Opportunities With Ethical Baggage

Anne McLaren

If all cells come from cells, as Rudolf Virchow postulated in the 1850s, all but the most short-lived animals must harbor a reserve of cells to replace those that die or are damaged. This reserve consists of stem cells (1). They are defined as those cells which can divide to produce a daughter like themselves (self-renewal) as well as a daughter that will give rise to specific differentiated cells. Stem cells in the body may be unipotent, like spermatogenic stem cells (which are responsible for the continuing production of spermatozoa), or they can be multipotent, like neural or hemopoietic stem cells, which give rise respectively to all the varied cell types in the nervous system or in the blood and immune system. Given the possibility of directed differentiation of stem cells, these multipotent somatic stem cell lines may prove to be of significant clinical value (2). Experimentally, it has also proved possible to create immortalized pluripotent stem cells. In 1981, pluripotent embryonic stem (ES) cell lines derived from mouse blastocysts were reported (3). These will proliferate indefinitely in vitro as undifferentiated cells, but will also differentiate when the culture conditions are modified, and when introduced back into an embryo, they will successfully colonize every cell lineage including the germ line. However, pluripotent stem cells cannot on their own make an embryo, that is, they are not *totipotent*. Undifferentiated ES cell lines have been extensively used in mice for genetic manipulation, including the introduction of new genetic material as well as knocking out and replacing genes. Later, similar pluripotential stem cell lines were derived from mouse embryonic germ (EG) cells (4). Despite energetic attempts, it proved extremely difficult to make ES or EG cell lines from any species other than the mouse. That changed in 1998 when James Thomson and colleagues in Wisconsin reported that they had derived human pluripotential stem cell lines from surplus blastocysts donated by patients undergoing infertility treatment involving in vitro fertilization (5). In the same year, John Gearhart and colleagues reported the derivation of human EG cell lines from aborted human fetal material (6). All these lines are now owned by Geron Corp. of Menlo Park, California; some others have been made elsewhere and are being studied in Australia.

Intense activity is now being focused on both mouse and human pluripotential stem cells, in an attempt to induce directed differentiation to defined cell types in culture, for example, by exposing the cells to signaling molecules such as retinoic acid and cytokines, as well as by genetic manipulation (7). The ultimate aim here is to supply transplant surgeons with a readily available supply of any tissue for the repair of damaged or diseased organs so that the need for organ donors would drop. Harold Varmus, until recently director of the National Institutes of Health (NIH), stated before Congress: "There is almost no realm of medicine that might not be touched by this innovation." Among the many medical possibilities are the use of cardiac muscle cells for heart problems, pancreatic islet cells for diabetes, liver cells for hepatitis, and neural cells for Parkinson's or Alzheimer's disease. In animal models, some successes have already been achieved: ES cell-derived cardiac muscle cells have been incorporated into damaged rat

hearts, and neural cells introduced into the brain of a mouse model of multiple sclerosis have differentiated into appropriate cell types (8).

In mice, EG cells introduced into embryos have led to some abnormalities, so they may be less suitable than ES cells for clinical use (9). ES cells raise ethical problems, however, as they are derived from early human embryos. Some people believe that fertilized human eggs and early embryos are already persons. They will therefore object to their use for research, even for such ends as cell and tissue therapy to reduce human suffering and disease. Others argue that, because the donated blastocysts will never be transferred to a uterus, it is preferable for them to be used for a beneficent purpose than to merely be left to perish. NIH is now prepared to fund research on human pluripotential stem cells that have been derived according to certain guidelines, but they will not fund the derivation of such lines.

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Dolly's False Legacy

There is more to cloning than mere science--and more to human character than scientists can discover in a person's genes

BY IAN WILMUT

The announcement in February 1997 of the birth of a sheep named Dolly, an exact genetic replica of its mother, sparked a worldwide debate over the moral and medical implications of cloning. Several U.S. states and European countries have banned the cloning of human beings, yet South Korean scientists claimed last month that they had already taken the first step. In the following essay for TIME, embryologist Wilmut, who led the team that brought Dolly to life at Scotland's Roslin Institute, explains why he believes the debate over cloning people has largely missed the point.

Overlooked in the arguments about the morality of artificially reproducing life is the fact that, at present, cloning is a very inefficient procedure. The incidence of death among fetuses and offspring produced by cloning is much higher than it is through natural reproduction--roughly 10 times as high as normal before birth and three times as high after birth in our studies at Roslin. Distressing enough for those working with animals, these failure rates surely render unthinkable the notion of applying such treatment to humans.

Even if the technique were perfected, however, we must ask ourselves what practical value whole-being cloning might have. What exactly would be the difference between a "cloned" baby and a child born naturally--and why would we want one?

The cloned child would be a genetically identical twin of the original, and thus physically very similar--far more similar than a natural parent and child. Human personality, however, emerges from both the effects of the genes we inherit (nature) and environmental factors (nurture). The two clones would develop distinct personalities, just as twins develop unique identities. And because the copy would often be born in a different family, cloned twins would be less alike in personality than natural identical twins.

Why "copy" people in the first place? Couples unable to have children might choose to have a copy of one of them rather than accept the intrusion of genes from a donor. My wife and I have two children of our own and an adopted child, but I find it helpful to consider what might have happened in my own marriage if a copy of me had been made to overcome infertility. My wife and I met in high school. How would she react to a physical copy of the young man she fell in love with? How would any of us find living with ourselves? Surely the older clone--I, in this case--would believe that he understood how the copy should behave and so be even more likely than the average father to impose expectations upon his child. Above all, how would a teenager cope with looking at me, a balding, aging man, and seeing the physical future ahead of him?

Each of us can imagine hypothetical families created by the introduction of a cloned child--a copy of one partner in a homosexual relationship or of a single parent, for example. What is missing in all this is consideration of what's in the interests of the cloned child. Because there is no form of infertility that could be overcome only by cloning, I do not find these proposals acceptable. My concerns are not on religious grounds or on the basis of a perceived intrinsic ethical principle. Rather, my judgment is that it would be difficult for families created in this way to provide an appropriate environment for the child.

Cloning is also suggested as a means of bringing back a relative, usually a child, killed tragically. Any parent can understand that wish, but it must first be recognized that the copy would be a new baby and not the lost child. Herein lies the difficulty, for the grieving parents are seeking not a new baby but a return of the dead one. Since the original would be fondly remembered as having particular talents and interests, would not the parent expect the copy to be the same? It is possible, however, that the copy would develop quite differently. Is it fair to the new child to place it in a family with such unnatural expectations?

What if the lost child was very young? The shorter the life, the fewer the expectations parents might place on the substitute, right? If a baby dies within a few days of birth and there is no reason to think that death was caused by an inherited defect, would it then be acceptable to make a copy? Is it practical to frame legislation that would prevent copying of adults or older children, but allow copying of infants? At what age would a child be too old to be copied in the event of death?

Copying is also suggested as a means by which parents can have the child of their dreams. Couples might choose to have a copy of a film star, baseball player or scientist, depending on their interests. But because personality is only partly the result of genetic inheritance, conflict would be sure to arise if the cloned child failed to develop the same interests as the original. What if the copy of Einstein shows no interest in science? Or the football player turns to acting? Success also depends upon fortune. What of the child who does not live up to the hopes and dreams of the parent simply because of bad luck?

Every child should be wanted for itself, as an individual. In making a copy of oneself or some famous person, a parent is deliberately specifying the way he or she wishes that child to develop. In recent years, particularly in the U.S., much importance has been placed on the right of individuals to reproduce in ways that they wish. I suggest that there is a greater need to consider the interests of the child and to reject these proposed uses of cloning.

By contrast, human cloning could, in theory, be used to obtain tissues needed to treat disorders such as Parkinson's disease and diabetes. These diseases are associated with cell types that do not repair or replace themselves, but suitable cells will one day be grown in culture. These uses cannot be justified now; nor are they likely to be in the near future.

Moreover, there is a lot we do not know about the effects of cloning, especially in terms of aging. As we grow older, changes occur in our cells that reduce the number of times they can reproduce. This clock of age is reset by normal reproduction during the

production of sperm and eggs; that is why children of each new generation have a full life span. It is not yet known whether aging is reversed during cloning or if the clone's natural life is shortened by the years its parent has already lived. Then there is the problem of the genetic errors that accumulate in our cells. There are systems to seek out and correct such errors during normal reproduction; it is not known if that can occur during cloning. Research with animals is urgently required to measure the life span and determine the cause of death of animals produced by cloning.

Important questions also remain on the most appropriate means of controlling the development and use of these techniques. It is taken for granted that the production and sale of drugs will be regulated by governments, but this was not always the case. A hundred years ago, the production and sale of drugs in the U.S. was unregulated. Unscrupulous companies took the opportunity to include in their products substances, like cocaine, that were likely to make the patients feel better even if they offered no treatment for the original condition. After public protest, championed by publications such as the Ladies' Home Journal, a federal act was passed in 1906. An enforcement agency, known now as the FDA, was established in 1927. An independent body similar to the FDA is now required to assess all the research on cloning.

There is much still to be learned about the biology associated with cloning. The time required for this research, however, will also provide an opportunity for each society to decide how it wishes the technique to be used. At some point in the future, cloning will have much to contribute to human medicine, but we must use it cautiously.

Team to attempt human cloning

CNN.com (March 9, 2001)

[ROME, Italy](#) (CNN) -- An international group of fertility experts has announced details of their plans to be the first scientists to clone a human being.

The group, meeting in Rome, discussed their strategy for human and so-called therapeutic cloning to help tackle a range of degenerative diseases.



The plan has come under heavy fire from scientific and religious camps and has been attacked as "grotesque" by the Vatican.

The team includes Italian obstetrician Severino Antinori, who became famous for helping a 62-year-old woman give birth.

Antinori said: "Cloning creates ordinary children. They will be unique individuals, not photocopies of individuals."

Bishop Elio Sgreccia, head of the John Paul II Institute for Bioethics at Rome's Gemelli hospital, said human cloning raised profoundly disturbing ethical issues.

"Those who made the atomic bomb went ahead in spite of knowing about its terrible destruction," he said before the cloning meeting started. "But this doesn't mean that it was the best choice for humanity."

Dr Ian Wilmut, who created Dolly, the world's first cloned sheep, said it took 277 tries to get it right.

Other cloning attempts have ended in malformed animals and experts say the technique fails in 97 percent of cases.

Antinori and his partner, U.S. scientist Panayiotis Zavos, say they plan to carry out the first operation in an unidentified Mediterranean country, starting in October.

Zavos, who first announced the proposal in Lexington, Kentucky, in January, told the symposium on Friday that he had been flooded by e-mail from couples seeking to have children through cloning.

"Dolly is here and we are next," he said.

Last year, Britain proposed allowing human cells to be cloned for research purposes while other European countries, including Spain and France have banned human cloning altogether.

Antinori first attracted controversy when he helped a 62-year-old woman have a baby eight years ago by implanting an egg in her womb.

In the cloning experiment, cells from an infertile father would be injected into an egg, which is then implanted in the mother's uterus for the pregnancy.

The resulting child would have the same physical characteristics as his father and infertile parents would not have to rely on sperm donors.

The chairman of the Human Fertilisation and Embryology Authority, Ruth Deech, said:
"There are lines you should not cross.

"You have to consider humanity as a whole and say there are limits beyond which we should not go for the sake of future generations and for respect for the autonomy and dignity of present generations."