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# HUMAN CLONING AND HALAKHIC PERSPECTIVES

## INTRODUCTION

On February 22, 1997, Dr. Ian Wilmut and his colleagues from the Roslin Institute in Scotland reported[1] a scientific breakthrough in cloning a mammal by fusing adult mammary cells to a host egg that lacked its own genetic material. Never before had scientists reported cloning a mammal by transfering DNA from an adult cell to an egg. Applying this technology to cloning human beings will most probably be accomplished within the next decade. In this paper we discuss the scientific basis of this technology, how it will impact medicine in ways that artificial insemination and *in vitro* fertilization could never achieve, and potential halakhic issues associated with this technology.

## SCIENTIFIC BACKGROUND

**DNA—THE BASIC UNIT OF GENETICS:** The genetic information for each human being is contained in the cells of the body as a set of double helical molecules called Deoxyribonucleic Acid or DNA. Cells from each person contain a unique set of genetic information. Except for identical twins, significant differences in the genetic information exist between any two individuals.

DNA is localized in two different areas within each cell. The majority of DNA is found in a cell structure called the nucleus, while some DNA (less than 1% of total DNA) is found in a separate structure of the cell called the mitochondria. The nucleus contains DNA derived from both the mother and father, while mitochondrial DNA is derived only from the mother and not the father.



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The genetic information encoded within the DNA controls the unique physiological and psychological development of each individual. Many human characteristics including hair color, body size, intelligence, susceptibility to disease, and behavioral characteristics are encoded in nuclear DNA. Even though there is much less genetic information in mitochondrial DNA as compared to nuclear DNA, it is nonetheless critical for proper human development. Mistakes in mitochondrial DNA can lead to diseases that dramatically affect muscle, kidney, heart and neurological functions.

**CLONING TECHNOLOGY USING ADULT TISSUE AS THE SOURCE OF DNA**: To clone a sheep from an adult cell the scientists at the Roslin Institute prepared an unfertilized host egg whose nucleus, including its genetic material, was physically removed. The mitochondrial DNA was not removed from the host egg. The scientists then obtained mammary cells from an adult ewe. These mammary cells were maintained in the laboratory under conditions with limited amounts of nutrients. In response to "nutrient-deficient conditions" these mammary cells reconfigured their DNA into a state similar to the DNA normally found in sperm or unfertilized eggs. The scientists then fused one mammary cell to one enucleated host egg by applying an electric current to the cells, thereby transferring the nuclear, and perhaps the mitochondrial DNA, from the mammary cell to the host egg. Moreover, the electrical current triggered the egg to respond as if it was fertilized and allowed the egg to reprogram the DNA it obtained from the mammary cell to initiate cell division and embryogenesis (a process by which a fertilized egg develops into a whole organism). This primitive embryo was maintained in the laboratory for about six days, until it reached an embryonic state called a blastocyte. The scientists then implanted the blastocyte into the uterus of a surrogate female sheep. About six months later, a healthy sheep named Dolly was born. Dolly was the first mammal ever created from DNA obtained from non-sperm adult tissue. Previously, scientists were only able to clone animals using either fetal or embryonic cells as a DNA source, but never using a cell from an adult.

The success rate to clone Dolly was quite low. Only thirty out of 277 host eggs that were fused with adult mammary cells grew to the blastocyte stage, and only one surrogate sheep was able to carry and deliver a healthy lamb. This success rate was, however, not much worse than previous studies using embryonic or fetal cells. In the last year and a half, however, the success rate for this technology has dramatically improved. As recently as mid-1998, several groups reported the cloning of

several cattle and mice from fetal cells with a success rate as high as 2-5%.

While newspapers refer to Dolly as a clone (i.e., an exact genetic duplicate of the donor sheep), it remains unclear whether she is technically a true genetic duplicate of the adult sheep who donated the mammary cells, because no one has reported whether Dolly contains mitochondrial DNA from the egg, the donor mammary cell or from both sources. Until this issue is resolved, the only way to ensure the generation of an exact clone would be to use a host egg and the adult mammary cell from the same female donor sheep.

## MEDICAL BENEFITS DERIVED FROM THIS TECHNOLOGY

The fear that humans could be cloned using this technology has triggered several governments and institutions to temporarily ban human cloning. While all the benefits and/or harm that can result from the technology of human cloning remains to be identified, the underlying science represents a potential medical breakthrough that should be pursued. Banning cloning research may terminate future scientific and medical discoveries that could have great potential in health care.

CORRECTING GENETIC DISEASES: Using the cloning technology developed by the Roslin Institute, scientists will have a new approach to manipulate the genetic information of human mammary cells in the laboratory and to correct genetic defects in the DNA. For example, if a man expresses a genetic disease, he will have a mutation (defect) in the DNA in all of his cells. He will pass that defective DNA to some or all of his offspring. If human cloning technology were developed, scientists could remove some of that individual's mammary cells, maintain them in the laboratory and genetically correct the DNA defect in those cells. A genetically altered mammary cell that does not carry this mutation could be fused with a host egg (obtained from his wife, whose nuclear DNA was removed) to create a clone (of the husband), who will not express or carry this genetic disease. Furthermore, the cloned child will now be able to have children via normal reproduction who do not express or carry the DNA defect for this genetic disease. Moreover, cloning technology using mammary cells provides unique advantages over *in vitro* fertilization technology. Sperm cells and fertilized eggs are quite difficult to genetically manipulate in the laboratory, whereas mammary cells can be genetically engineered in the laboratory. Diseases

that are directly caused by, or influenced by "defects" in the DNA include Tay Sachs disease, cystic fibrosis, Huntington's disease, many forms of cancer, heart disease, diabetes, and Alzheimer's disease.

INFERTILITY: Cloning technology using adult tissue could be used to help a woman unable to produce live eggs, or a male unable to produce live sperm, to have children that are biologically related to at least one of them (depending on the source of the donor DNA). Similarly, a couple whose infant child is dying as a result of a car accident might request that the appropriate cells (either from mammary tissue or bone marrow) from their dying child be removed and used to clone that child. Even if the child were declared legally dead, live cells could be collected from specific tissues for several hours after the heart or brain ceased to function. The mother could even supply the host egg and carry the nearly perfect genetic copy of the dead child.

NOVEL CANCER TREATMENTS AND TISSUE REGENERATION: Cloning technology could form the basis for a whole new therapeutic approach to treat the most common and fatal human diseases. To comprehend how this new treatment would work requires a simple understanding of embryogenesis, the process by which a complex organism is formed from a single fertilized egg. The human body is constructed from about 200 crudely distinguishable types of cells. Each of these different specialized cell types is characterized by its different functions, but they all arise from one fertilized egg. As the cells of the egg divides, the daughter cells change, or differentiate, and become specialized cells. Specialized cells include blood cells, kidney cells, liver cells, nerve cells, muscle cells, etc., which form the different tissues and organs of the body.

If all cells in a person contain the same genetic information, how can a person have such a variety of specialized cells? How does one fertilized egg develop into specialized cells and tissues? Why do nerve cells function differently than muscle cells? The answer to these questions is that as a cell changes into its own specialized cell type, different regions of its DNA are turned off (inactivated) or turned on (activated). For example, a nerve cell may require the genetic information encoded in parts of chromosome #5 while not requiring the genetic information encoded in parts of chromosome #8. In contrast, a muscle cell may require the genetic information encoded in parts of chromosome #8, but not the genetic information encoded in parts of chromosome #5. Thus, each specialized cell type in the body contains large regions of genetic information that have been selectively turned on or off. Until

Dolly was created, the mechanisms by which cells inactivate regions of DNA were thought to involve irreversible chemical modifications of the DNA or DNA-associated proteins. However, the underlying technology used to clone Dolly disproves the dogma that DNA inactivation is irreversible and suggests that the host egg has the capacity to reprogram the DNA of an adult cell to initiate embryogenesis. Thus, the whole DNA of the adult mammary cell is made accessible by the egg to direct the formation of all the specialized cells of the body.

How could this technology be applied to medicine? Unlike most cells of the body, nerve cells from an adult are unable to divide or replicate. This means that when nerve cells are destroyed in patients with Parkinson's or Alzheimer's disease, they cannot be replaced by the adjacent healthy nerve cells. If scientists could mimic the mechanism by which the host egg turns on the previously inactive regions of the DNA in the adult cell, they could apply this process to reprogram adult nerve cells to divide again. Thus, a person who develops Alzheimer's or Parkinson's disease could be treated with drugs that would stimulate new nerve regeneration, replacing the damaged nerve cells of the brain.

Cancer is another disease that could be treated using a similar process. In cancer, the capacity of cells to divide becomes unregulated, and cells proliferate uncontrollably to form large and destructive tumors. The knowledge about reprogramming DNA regions in a cell would create therapeutic strategies to reprogram cancer cells to revert back to their pre-cancerous state, thereby stopping the cancer growth.

**ORGAN REPLACEMENT:** Currently, organs from non-human sources cannot be used as transplant material in people because they contain non-human proteins that trigger tissue rejection when transplanted into humans. Cloning technology applied to animals could be used to create genetically engineered animals, like pigs, that contain internal organs that are immunologically compatible to humans. Organs from these genetically modified pigs could serve as replacement tissues for patients requiring heart, liver or lung transplantation without the danger of tissue rejection.

**POTENTIAL PROBLEMS:** Only continued experimentation with animals will uncover the potential medical problems that could occur using this technology for cloning humans. While Dolly did not express any detectable medical problems, it is possible that medical defects may arise because this technology utilizes adult cells as the source for DNA, and these cells may have acquired environmental defects. In addition, the

DNA of adult cells differ from that of fetal cells. Thus, the question arises whether a cloned person from an adult cell will have a shortened lifespan because the DNA was from an adult source. Moreover, the psychological implications of being a "human clone" of one parent or of a famous individual can only be evaluated using human subjects.

## FUNDAMENTAL HALAKHIC ISSUES RELATED TO CLONING TECHNOLOGY

One of the earliest articles that discussed some of the halakhic considerations of cloning was written by Azriel Rosenfeld.[2] Recently Rabbi Michael Broyde wrote an excellent article reviewing some of the halakhic issues related to human cloning[3].

POTENTIAL ARGUMENTS SUPPORTING HUMAN CLONING: Human cloning may be considered permissible for several reasons. First, it is not discussed directly in the Torah. *Tiferet Yisrael* on *Yadayim*[4] states that when the Torah does not specifically prohibit an activity it is permissible to do it. Second, cloning is based on established biological principles that do not seem to involve any defined halakhic prohibition (assuming that there are no serious medical or harmful effects of cloning.) Third, according to Ramban,[5] God gave man the right to master all powers embedded in the physical, chemical and biological sciences in order to "rule the world" [*kivshuha*]. Thus, human cloning represents a powerful biological force that man could explore and control. Finally, cloning technology appears to have great medical potential, and a basic tenet of the Torah, as expressed in the phrase *ve-rappo ye-rappe,* is that Jews are permitted and obligated to utilize all available technology to heal the sick.[6]

In fact, cloning technology might provide a halakhic advantage over artificial insemination or *in vitro* fertilization for the infertile couple. In both artificial insemination and *in vitro* fertilization, the non-coital procurement of sperm by the male is halakhically problematic.[7] In the case of human cloning, the male would only have to donate mammary cells or some other non-sperm cell, thereby avoiding any problem of *hotsa'at zera le-vatala.* Thus, for the infertile couple, one might consider this cloning technology over artificial insemination or *in vitro* fertilization to avoid any potential *isurim.*

POTENTIAL ARGUMENTS THAT MAY FORBID HUMAN CLONING: *Derekh ha-teva:* The concept that a Jew should follow the *derekh ha-teva* is quot-

ed by both Ramban[8] and *Sefer haHinukh*[9] as one reason why *kishuf* (magic) and *kilayim* are prohibited practices. The idea of creating human life via replication (i.e., the absence of normative sexual reproduction) may go against a general dogma that God directed human life to be formed through natural sexual processes. This application of *derekh ha-teva* might include the principle that each human being possesses an inalienable right to be a product of two sexually different parents, and that each parent must contribute *zera* (seed) to the formation of a child.

There are at least two unique factors in cloning technology that may be related to the issue of *derekh ha-teva.* First, no *zera* from the man is used to create the child, and second, the creation of human life can be achieved in the absence of men or male-derived tissue. In contrast, both *in vitro* fertilization and artificial insemination require a male to donate sperm. The *hashkafa* of the *gemara* in *Nidda* 31a and *Kidushin* 30b implies that the preferred method of human procreation requires both a man and a woman. The *gemara* there states that three partners (God, man, and woman) are required for the creation of a human being, and that *zera* of both man and woman contribute to the development of the child. Thus, human cloning using current technology may present a halakhic problem with respect to *derekh ha-teva.* However, since there are no primary sources that specifically prohibit other ways of procreation (such as asexual reproduction), perhaps the *gemara* simply describes the preferred method of procreation while not forbidding other methods.

Cloning a human from male and female tissue may not go against the *hashkafa* of procreation, while using only female tissue to clone a female may create a problem. *Mizrahi* on *Bereishit* (4:1) quotes an interesting passage from the *Midrash Rabba*[10] which relates that Hava named her first born son Kayin because *kaniti ish et Hashem,* which Rashi translates as "I have acquired a man with God." The *midrash* further states that Adam was created from *adama,* Hava from Adam and from then on *be-tsalmenu ki-dmutenu*—no man without woman, no woman without man and not both of them without the *Shekhina.* At the very least, this *midrash*[10] and the above *gemaras (Nidda* 31a and *Kidushin* 30b*)* suggest that cloning a child using an egg and a mammary cell from two women or from one woman might be prohibited, while cloning a child using an egg from a woman and a donor cell from a male might be acceptable.

*Medical risks:* Halakha might prohibit human cloning if it were associated with a significant medical risk. At this point there is no evidence of

any health risks associated with this technology. While a majority of the transplanted "cloned" embryos will spontaneously abort at various stages of development, this may not represent a halakhic problem because spontaneous abortion occurs frequently in normal pregnancies and even more frequently (up to 30%) in couples utilizing *in vitro* fertilization. A potential medical risk that could impact halakha is whether the cloned child will suffer greater birth defects or psychological stress being a clone. However, it is not expected that "cloned" children will suffer any greater personality dysfunctions or adjustments than twins created naturally or via *in vitro* fertilization. Nonetheless, issues of identity and individualism must be assessed in order to determine whether there are any psychological risks involved in cloning.

*Eugenics:* Many secular ethicists claim that a primary ethical issue in human cloning is eugenics, which refers to the selected breeding of the human race. Cloning technology could be used to create clones from a *gadol ha-dor* or from "evil" individuals such as Saddam Hussein. These ethicists propose that cloning is a potentially dangerous force similar to atomic power. While atomic power can be used to benefit society by building energy plants, it can also cause massive destruction when used in bombs. Similarly, human cloning may cause massive destruction if used to create dangerous individuals or an army of super-fighters. However, the dangers to society of human cloning differ dramatically from those associated with atomic energy. Cloning a copy of Hussein will not guarantee that the clone will grow up to become "evil," because environmental factors play a significant role in the psychological and moral development of humans. Furthermore, character development of the cloned child, as with non-cloned children, requires many years and is subject to unexpected social and environmental influences. Even if one can demonstrate that cloned individuals can be socially trained to acquire the personality of the "genetic parent", the halakhic prohibition might be related to raising "evil" clones and not creating a clone per se.

Interestingly, the *gemara* in *Nedarim* 81a may relate to the issue of cloning a *gadol ha-dor.* The *gemara* states that families of *talmidei hakhamim* do not necessarily have children who are *talmidei hakhamim,* because according to Rav Yosef, the development of a *talmid hakham* is not "genetically" (the language of the *gemara* is *yerusha*) determined. Obviously Rav Yosef understood the differential impact of "nature" (genetics) verses "nurture" (social environment) on human psychological and moral development.

*Kishuf*: Could cloning be included in the prohibition of *kishuf* (using supernatural processes)? Rambam[11] and Rabbenu Hananel[12] define *kishuf* as a form of idol worship involving practices or processes that simply do not work.[13] However, according to *Sefer haHinukh*,[14] *kishuf* (and *kilayim*) are *halakhot* that are part of an imperative to preserve distinct life species (*le-mineihu*) created by God. This imperative to preserve distinct life species is developed and discussed by Ramban,[15] Rashba,[16] and the Gaon of Vilna.[17] These *rabbanim* claim that by creating new life forms via genetic manipulations (in the case of *kilayim*, by planting two different crops in the same field or cross breeding different animal species) one is transgressing the prohibitions against *kilayim* and *kishuf*.

According to Rambam[11] and Rabbenu Hananel,[12] who believe that *kishuf* involves processes that are not real and do not work, cloning would not be included in this prohibition. Even according to those *rabbanim* like the *Hinukh* and Ramban, who understand the *issur kishuf* as preserving *le-mineihu*, human cloning may not be prohibited because: 1) it is being utilized to preserve the human species, and not to create different human life forms; 2) according to Ramban, *kishuf* is only prohibited if utilized for *malakhei habala* (evil purposes), which does not necessarily apply to human cloning, and 3) human cloning technology is based on defined biological processes and not "magical or supernatural" processes. While one could argue that there is no direct evidence that cloning would fall under the halakha of *kishuf* according to any view. There is an important halakhic lesson to be derived from *kishuf*. While the *gemara*[18] suggests that *kishuf* was a major transgression that triggered the destruction of the world in the time of Noah, *Shulhon Arukh*[19] states that for medical purposes it is completely permissible to grow different crops in one field. Similarly, based on the *gemara* from *Shabbat* 67a, the *Hinukh* allowed *kishuf* if a medical benefit can be achieved. The lesson here is that potential medical benefits of any technology (including human cloning) may override halakhic problems associated with that technology.

The above discussion focused on using human cloning as a medical intervention. However, the use of cloning technology for non-medical reasons or for commercial reasons may present a unique halakhic issue that must be resolved by the appropriate rabbinical authorities. For example, would it be halakhically permissible to clone five Michael Jordans to try to create a highly profitable championship basketball team?

## HALAKHIC ISSUES RELATED TO THE CLONED INDIVIDUAL

ARE CLONES FROM HUMANS HALAKHICALLY HUMAN? One would assume that human clones will eventually be created whether or not cloning is halakhically permitted or prohibited, and the halakhic status of these clones will have to be evaluated. A critical halakhic concern in cloning is whether a clone created in the absence of sperm (or "*zera*"), sexual relations or even without utilizing any cells from a man (i.e., when the host egg and donor DNA are obtained from the same woman) is considered according to halakha to be a human being. If such a clone is not halakhically human will it be defined as a *golem* (for a discussion of the creation and halakhic issues related to a *golem* see references).[20] If a human clone were defined as a *golem* then many halakhic issues would have to be resolved. For example, could a *golem* be killed without halakhic penalty? Could a Jew marry a *golem*? What would be the halakhic status of any of its offspring?

There are, however, two factors that differentiate a *golem* (as described in the *gemara*[21]) from a human clone. First, a *golem* is created by means of chanting "mystic combinations of the Divine Name" (obtained from *Sefer Yetsira*) over selected dust of the earth, while human clones are created using biological technology and human cells. Secondly, unlike a cloned human, a *golem* is not born from a mother's womb. According to criteria of *Hakham Tsevi*,[22] an organism is human if it was delivered from a human female.[23] Therefore, a human clone does not fit the definition of a *golem* and appears to be halakhically human. However, if technology develops that would allow babies to be formed and developed ex-utero (outside a woman's womb) or in the uterus of another animal such as a cow, then the halakhic status of such life-forms might have to be re-evaluated.[24]

MITSVA OF PIRYA VE-RIVYA: Does the couple that engages in human cloning fulfill the *mitsva* of *pirya ve-rivya*? The same two problems described above (i.e., the lack of male *zera* or male tissue, and the absence of sexual relations) will determine this issue. The problem of creating children in the absence of sexual relations (i.e., via artificial insemination or *in vitro* fertilization) with respect to *pirya ve-rivya* has been debated before and a more complete discussion of the various opinions has been summarized.[25] What is relevant to this discussion is the question of whether this *mitsva* can be fulfilled only when a child is born out of natural sexual intercourse or if this *mitsva* is fulfilled when a

viable child is born irrespective of how or where fertilization takes place. While there is a precedent for artificial insemination in *Hagiga* 14b, there is no established precedent in the *gemara* or Hazal for propagation of humans in the absence of male seed (i.e., human cloning). Thus, the absence of male *zera* and sexual relations may imply that the *mitsva* of *pirya ve-rivyah* may not be fulfilled via cloning. However, it is possible that cloning will fulfill the secondary *mitsva* or rabbinical obligation of *la-shevet* (to populate)—to have children.

WHO ARE THE HALAKHIC PARENTS OF A CLONED CHILD? The answer to this question is critical in order to establish: 1) who the child is forbidden to marry; (2) whether the child is a *Kohen*, *Levi*, or *Yisrael*; 3) whether the child is a *bat Kohen*; 4) which parents must the child respect according to halakha; 5) whether the child is a Jew or Gentile; 6) when the laws of *yibbum* (levirate marriage) apply, and 7) how the laws of inheritance.

A few of these issues can be explored in a case where both the host egg and the donor mammary cell are obtained from the same mother. That woman then carries that fetus in her womb, and will deliver a girl who will be a perfect clone of the mother because both the nuclear and mitochondrial DNA were obtained from the host mother. In this case no male cell or sperm directly contributed any DNA in the creation of this cloned girl. Since the girl was delivered by its genetic mother and contains all the DNA from a Jewish mother, the baby girl should be Jewish. But who is the halakhic "father" of this cloned child? There are three possibilities:

1) The father of the mother, or the grandfather of the cloned girl would be the father because about half of his genetic information is transmitted to the child through the host mother;

2) The donor of the mammary cell, who in this case is the biological mother, would be the halakhic father. Thus, the biological mother would then serve as both the halakhic father and halakhic mother of this cloned baby; or

3) The cloned girl will have no halakhic father.

There are no defined cases in halakha where either a grandfather (who did not directly donate any cells or DNA to form this child) or a mother can serve as the halakhic father. Thus, there are no direct

halakhic precedents in the *gemara* supporting possibilities 1 or 2. There are, however, at least two cases in the *gemara,* namely *shetuki* and *gerut,* where a child lacks a halakhic father. A *shetuki*[26] is defined as an individual who does not know his/her biological father either because the mother refused to tell him/her or because the mother did not know herself. The halakha concludes that a *shetuki* may not marry any other Jew, because the identity of the father is not known and halakha wants to ensure that the child does not marry a relative.[27] However, there is a fundamental difference between a *shetuki* and a human clone, because in the case of a *shetuki,* a biological father does exist but is unknown. In the case of the cloned girl no biological father exists, because no male *zera* was used to produce the child. Moreover, the "genetic *kerovim*" of a clone are known and can be halakhically defined. Thus, this cloned child may be forbidden to marry *kerovim* established by halakhic criteria and allowed to marry any non-relative. One might even adopt a stringent halakhic ruling to expand the definition of *kerovim* to include relatives of the biological grandfather as if he were considered the halakhic father.

*Gerut* is a situation where all halakhic family ties are severed after conversion. A person who converts to Judaism is classified as not having any halakhic father or mother. *Gerut,* however, represents a complicated situation, and rabbinical authorities must determine if it is a valid precedent to our cloning situation to establish whether a cloned child lacks a halakhic father.[28]

The following case illustrates how truly complex halakhic issues may arise with cloned children. Let's assume that the mitochondrial DNA is still maternally transmitted in a clone. Now suppose the donor DNA was obtained from another (non-related, non-Jewish) woman, and the host egg is obtained from a Jewish woman who carries and delivers the child. Here two separate females have contributed the nuclear and mitochondrial DNA to create a female baby. Since Jewishness is maternally transmitted, what is the status of this cloned child? Genetically this child is primarily composed of non-Jewish DNA but was carried in utero in a Jewish host. Hazal have not yet differentiated between nuclear DNA and maternally transmitted mitochondrial DNA with respect to defining the Jewish status of a child. Most likely, the resolution of this issue will depend on how one views the status of surrogate motherhood. If the birthing mother is defined as the halakhic mother then the child is Jewish even though her genetic makeup is primarily non-Jewish. If the genetic mother defines the status of the child then the child is not Jewish. If both women play a halakhic role in

"motherhood" then halakha may require the cloned child to undergo conversion to ensure its Jewishness.[29]

What is the halakhic status of a female child which arose from the fusion of an enucleated egg with a cell from a female "*karov*" (relative) of the host mother? Is it permissible to clone a child using an egg of a woman and the DNA from the cell of her daughter, or mother or sister? Nowhere does the Torah or Hazal forbid the union of a mother with a daughter to form a child because such a possibility was never envisioned. If one applies the principle of the *Tiferet Yisrael* on Yadayim,[4] one might allow such a procedure since it was never discussed in halakha. Nonetheless, the halakha of generating such children remains to be resolved.

There is no clear halakhic precedent to resolve the issue of defining the *yihus* (i.e., *Kohen, Levi* or *Yisrael*) of a cloned male child even when the husband donated his mammary cell and the wife donated her egg. Halakha must deal with whether a child's status as *Kohen* or *Levi* is dependent upon: 1) the child being created from the "*zera*" of a *Kohen*-father or *Levi*-father or 2) the child being created via sexual relations. Equally important, will a man whose brother dies be required to do *halitsa* to the surviving wife *(yivama)* if she has a cloned child from her deceased husband?

THE ISSUE OF *MAMZERUT*: Can DNA be used from a male (Jew or non Jew, relative, or *mamzer*) other than the husband of the woman for cloning, and would the resulting child be classified as a *mamzer*? The answer may relate to the definition of *mamzer* by *Shulhan Arukh*,[30] who characterizes *mamzerut* as being hereditary and paternally transmitted. However, a *mamzer* status may never be achieved in cloning since no male *zera* or sexual relations were involved in the conception of the child. If *mamzerut* is defined as requiring a *zera zar* (foreign sperm),[31] then in the case of cloning no such *zera* was involved. Furthermore, if one believes that such a cloned child has no halakhic father then the child could never attain a state of *mamzerut* in this scenario.

The philosophy of the Talmud[32] and halakha[33] is to provide ways for *mamzerim* to be "purified," i.e., to have Jewish children who are non-*mamzerim*. Thus, it is conceivable that the cloning technology may provide a halakhically permissible method for *mamzerim* to have Jewish children. However, further halakhic analysis is required to clarify whether another man or a *karov* would be allowed to donate non-*zera* DNA to a married Jewish woman.

SOCIAL IMPLICATIONS: One of the most interesting social implications of this cloning technology is that men will not be needed for women to have children. It is possible to envision the creation of "tissue banks" similar to sperm banks, where individuals would donate cells to clone children like themselves. There would be no halakhic prohibition of donating non-sperm cells, unlike artificial insemination or *in vitro* fertilization, where a male must donate sperm. At this point in time it is unclear how inexpensive or common cloning will become, but it will offer a male-free method for having children. In other words, human cloning represents a form of replication, not reproduction that reflects a major departure from the way we normally have children.

Rabbi Waldenberg[34] felt that halakha would have a negative view of implementing any fundamental social change in the basic family unit. Ideally, both men and women should be involved in the reproduction and raising of children. Rabbi Eliashiv[35] claims that cloning offers a social change that would go against *hashkafat haTorah* with respect to the role of parents in raising children. Furthermore, the issue whether a single woman could clone herself may relate to a *pesak* of Rav Auerbach,[36] who writes that single women should not bear children via artificial insemination even when the donor is Jewish. One could infer that children should only be born within a nuclear family structure. Clearly, the social implications of cloning and living an asexual life-style must be further examined by rabbinical authorities.

There may be those who feel that if the major governments or religions of the world forbid an activity, such as cloning, it may be a *hilul Hashem* for Jews to engage in such an activity even though there is no intrinsic *issur*. This position appears to fall within the framework of a *teshuva* by *Helkat Ya'akov*,[37] although he did not specifically address human cloning.

## CONCLUSIONS

It is important to remember that the United States was one of many countries to ban *in vitro* fertilization when it was first reported almost twenty years ago. Only England and Australia allowed *in vitro* fertilization, developed the technology and demonstrated its medical benefits. Today, it is an important infertility treatment among Jews and non-Jews in the United States and around the world.

The development of technology by which mammals could be cloned using adult (non-reproductive) cells as the donor DNA repre-

sents a seminal milestone in the new era of human genetic engineering. In addition, this technology and its underlying science have the potential to create new and exciting therapeutic approaches for treating a variety of human diseases, such as cancer and neurological disorders. Even though many nations have banned human cloning, it would be a mistake to stop all biomedical research that examines how the host egg reprograms DNA. The Bond-Frist bill in the US Senate and the Ehlers bill in the House go far beyond restricting the cloning of humans. These bills would put a stop to all cloning experiments that use human cells. Never before has Congress passed legislation to halt a single kind of scientific or medical research. We therefore propose that research on cloning animals should continue in order to derive potential medical benefits that will emerge from such research. Research on cloning using human tissue should be limited and carefully regulated. No cloned blastocyte or embryo should be implanted in surrogate mothers for at least the next few years until international committees are convened to discuss the medical, regulatory, ethical, and moral issues of human cloning. Such discussions took place in the 70's and 80's when recombinant DNA technology was introduced. Needless to say, this DNA technology has yielded enormous medical benefits.

In general, there may be no intrinsic problems with cloning humans using this technology, especially if used as a form of medical intervention for infertility or to correct genetic defects in children. However, some *poskim* may believe that the major potential halakhic problems in cloning are the issues of *derekh ha-teva,* and the potential negative social implications that may arise from this technology. In either case the halakhic status of the cloned children is an area of halakha in which there are no clear precedents, but nonetheless resolvable. Thus, we propose that the halakhic community create an international committee and symposium composed of leading rabbinical figures and religious scientific experts to discuss the halakhic ramifications of cloning using these technologies. While an in-depth dialogue between scientists and rabbis on the issue of human cloning should be encouraged, the final *pesak* of these complex issues should be determined by *gedolei ha-dor.*

## NOTES

1. I. Wilmut, A. E. Schnieke, J. McWhir, A.J. Kind, and K.H. Campbell, "Viable Offspring Derived from Fetal and Adult Mammalian Cells", *Nature* 385 (1997), pp. 810-813.

2. A. Rosenfeld, "Human Identity: Halakhic Issues", *Tradition* 16 (1977), pp. 58-74.
3. M. Broyde, "Cloning People and Jewish Law: A Preliminary Analysis", *Journal of Halacha and Contemporary Society* 34 (1997), pp. 23-65.
4. *Tiferet Yisrael* on *Yadayim* 4:3.
5. *Ramban* on *Bereishit* 1:26 and 1:28.
6. *Exodus* 21:19 and *Bava Kama* 85a.
7. Avram Steinberg (ed.), *Encyclopedia Hilkhati-Refuit* vol. 2., pp. 407-426; S.J. Zevin, *Talmudic Encyclopedia* vol. 11, pp. 129-141.
8. *VaYikra* 19:19. There Ramban appears to assert that one who grafts different species violates the command "You shall keep *hukotai* (my statutes)", and mixes up the work or order of creation.
9. #62 #244, .and #245.
10. *Bereishit Rabba* 22:2 and 1:26.
11. *Perush haMishnayot Avoda Zara* 4:7; *Mishne Torah, Avoda Zara* 11:16.
12. *Sanhedrin* 67b.
13. *Encyclopedia Talmudit* vol. 1, s.v. *"Ahizat Einayim".*
14. *Mitsva* #62.
15. *Deuteronomy* 18:9.
16. *Responsa Rashba* #413.
17. *Yore De'a* #179 and 113.
18. *Sanhedrin* 105b
19. Laws of *Kilayim* 297:3
20. *Sanhedrin* 65b and *Responsa Hakham Tsevi* #93; *Responsa She'eilat Yavets,* part 1:41 and part 2:82; *Gevurot Shemonim* #52; *Responsa Tsafnat Paneah* pt. II, no. 7 (Jerusalem edition, 1987); *Kerem Hemed Orah Hayyim* par. 3 (Livorno, 1989).
21. *Sanhedrin* 65b.
22. *Responsa Hakham Tsevi* #93.
23. Also see *Nidda* 23b and Rabbi J. David Bleich, *Contemporary Halakhic Problems* vol. IV, p. 271.
24. *Haggiga* 14b.
25. *Encyclopedia Hilkhatit Refuit* by Avam Steinberg vol. 1, p. 153 and vol. 2, pp. 138-139.
26. *Kidushin* 73a.
27. *Kidushin* 73a, *Rambam Hilkhot Issurei Bi'a* 15:21. *Responsa Seridei Eish helek* 3, #5.
28. See J. David Bleich, *Contemporary Halakhic Problems* vol. IV, pp. 237-272 on other issues of *gerut* and parent-child relations.
29. See J. David Bleich, *Contemporary Halakhic Problems* vol. IV, pp. 237-272; *Encyclopedia Hilkhatit Refuit,* vol. 2 pp. 129ff.
30. *Even haEzer* 4:18, 22:24 and 154:20.
31. See *Encyclopedia Hilkhatit Refuit* vol. 1, p. 157.
32. *Kidushin* 69a.
33. *Shulhan Arukh, Even haEzer* 4:20 and 8:5.
34. Responsa *Tsits Eliezer* vol. 15, #45-4.
35. Personal communication.
36. *Nismat Avraham,* vol. 4, E.H., 1:3.
37. Vol. 3, #45.