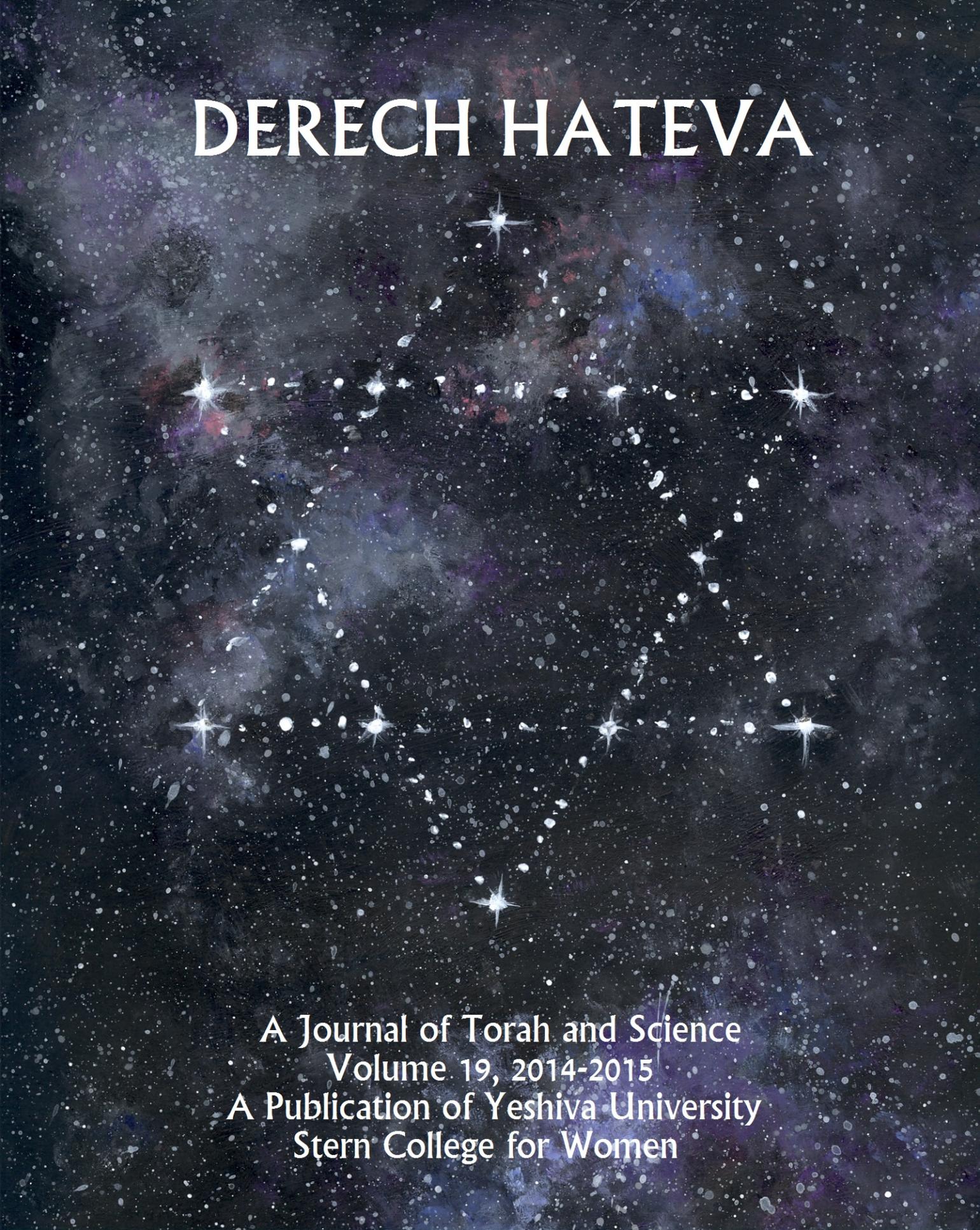


# DERECH HATEVA

The background of the cover is a dark, starry night sky. In the center, there is a prominent constellation of stars that form a large, irregular shape, possibly representing the constellation of the Southern Cross or a similar pattern. The stars vary in brightness and size, with some being very bright and sharp, while others are smaller and fainter. The overall color palette is dark, with shades of black, deep blue, and purple, punctuated by the white and yellow light of the stars.

A Journal of Torah and Science  
Volume 19, 2014-2015  
A Publication of Yeshiva University  
Stern College for Women

**DERECH  
HATEVA**

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We would also like to thank the following donors who have helped fund the publication of volume 19 of Derech HaTeva. Thank you for making this opportunity possible.

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## Dedication

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The editors of *Derech HaTeva* as well as the Yeshiva University community would like to dedicate the 19th volume of *Derech HaTeva: A Journal of Torah and Science* in memory of our fellow student Julia Packer a”h. Julia was a senior at Stern College for Women when she passed away at the age of 22 on January 31st, 2015.

Known for her sweet and warm demeanor, Julia’s contagious smile brought much happiness to her family and friends. She treated those around her with kindness and compassion, and her gentle soul made her a comforting and joyful person to be around. Julia was also a talented artist whose works were greatly admired by faculty and students alike. Her special vivacity will long be remembered and treasured by all who were touched by her beautiful spirit.

When the biblical prophetess Hannah was blessed with a child following many years of infertility, she sang what is known as “Shirat Hannah,” a poem that marvels at the wonders of which God is capable of. In this poem of thanksgiving, Hannah praises God and sings, “ain tzur k’Elokeinu” (Samuel I 2:2), which literally means, “there is no stronghold like God.” The 11th-century biblical commentator Rashi adds that this verse can alternately be read as, “ain tzayar k’Elokeinu,” which means, “there is no artist like God.”

The marvelous wonders that God is able to design are clearly evident in the myriad of scientific processes that scientists and laymen alike are affected by every day. As a person who emulated God both in the way she conducted her life as well as in the talents that she exhibited, it is only befitting that a journal devoted to understanding the complexity, beauty, and artistry of science should be dedicated to Julia.

החיים בצרור צרורה נשמתה תהא

שאו מרום עיניכם וראו מי ברא  
אלה המוציא במספר צבאם לכלם  
בשם יקרא מרב אונים ואמיץ כח  
איש לא נעדר

Lift up your eyes on high, and behold  
Who has created these things; Who  
brings out their host by number, He  
calls them all by names by the greatness  
of His might, and because He is strong  
in power not one is missing.

Yeshayahu 40:26

## Table of contents

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<b>Michal Auerbach</b> , <i>Postmortem Sperm Insemination: A Halachic Survey</i> .....	7
<b>Rebecca van Bemmelen</b> , <i>God Bless You! - Smell and Spirituality</i> .....	10
<b>Emily Chase</b> , <i>Colors of Judaism</i> .....	12
<b>Tehila Feinberg</b> , <i>Halachik Considerations of IVF</i> .....	14
<b>Talia Felman</b> , <i>The Epigenetics of Children of Holocaust Survivors</i> .....	16
<b>Rebecca Garber</b> , <i>The Eighth-Month Conundrum</i> .....	18
<b>Sima Grossman</b> , <i>Mitochondrial Replacement Therapy and Jewish Law</i> .....	20
<b>Rachel Hersch</b> , <i>Contagious Diseases and Vaccination; A Halachic Perspective</i> .....	23
<b>Yael Horvath</b> , <i>A Suggested Mechanism to the Hardening of Pharaoh's Heart: A Study in Mind-Controlling Parasites</i> .....	25
<b>Ariella Levie</b> , <i>Black Jews of Africa: Beliefs, Customs, and Genetics</i> .....	27
<b>Elana Perlow</b> , <i>Whose Blood is Redder? A Halachic Analysis of Issues Related to Separation of Conjoined Twins</i> .....	30
<b>Chana Ratner</b> , <i>BRCA1:185delAG. Just an 'Ashkenazi Mutation'?</i> .....	33
<b>Jeni Rossberg</b> , <i>Ancient Maladies: An Exploration of Disease and Pathophysiology in Tanach and the Talmud</i> .....	35
<b>Jessica Roussel</b> , <i>Opus Number Eight</i> .....	38
<b>Miriam Saffern</b> , <i>A Torah Basis for Limits and Mathematical Infinity</i> .....	40
<b>Michal Schechter</b> , <i>Mei Teveryah in Rabbinic Literature: Medical and Halachic Issues</i> .....	43
<b>Nora Shokrian</b> , <i>Crown: To Wear or Not To Wear</i> .....	45
<b>Rebecca Tabaroki</b> , <i>The Roots of Contemporary Podiatric Medicine in Biblical Times</i> .....	47
<b>Allison J. Tawil</b> , <i>Compassion towards People with Disabilities: The Torah Perspective</i> .....	49
<b>Rachel Weil</b> , <i>The Yom Kippur Effect</i> .....	52
<b>Stephanie Zerbib</b> , <i>Strings of Blue</i> .....	53
<b>Dr. H. Babich</b> , <i>Halacha meets DNA fingerprinting</i> .....	55



# Postmortem Sperm Insemination: A Halachic Survey

Michal Auerbach

A young Israeli soldier dies Al Kiddush Hashem in battle. His widow asks to procure some of his sperm so that she can have his child. A young man is killed in a sudden accident. He and his wife have been trying to have children for a few months before he is killed. His widow asks if she can continue their endeavors even after his death.

These are only a sampling of the various situations for which postmortem sperm insemination would be the only means of having a child. What does the halacha say about such situations? What issues would result from the fact that the entire procedure takes place after death? Does the child post-facto fulfill the obligation of *pru u'revu* that his father was not able to fulfill? Moreover, what is the resulting halachic status of the child?

The procedure of sperm procurement for insemination is not a complicated one, nor a recent advancement [1]. The first case of successful artificial insemination in humans was performed in 1770 by a surgeon named John Hunter. The procedure did not work well until 1949, when it was discovered that adding a small amount of glycerol to the sperm before freezing would drastically increase chances of sperm vitality. Artificial insemination is now ubiquitous, and modern technology has made it readily accessible [2]. This accessibility has given rise to numerous requests for postmortem sperm procurement, in the hopes that a baby will be born using this procedure. According to Dr. Richard V. Grazi, director of Genesis Fertility and Reproductive Medicine, and Dr. Joel B. Wolowelsky, Chairman of Advanced Placement Studies at the Yeshivah of Flatbush, “[b]etween 1980 and 1995, eighty-two requests for postmortem sperm procurement were reported at 40 facilities in 22 different states.” More than half of the reported requests were made in the last two years of the data, indicating that this is a growing issue that should be immediately addressed [1].

This article will focus on one type of artificial insemination, artificial insemination by husband (AIH). In this procedure, semen is procured from the husband, and is inseminated by means of a syringe into the wife at her time of ovulation [2]. The procedure is not all too different when being performed postmortem. Before one can attempt to approach tough halachic questions on this topic, the premise must be established: is the man halachically dead? The legal criterion for death is brain death, but there is debate between halachic authorities whether this constitutes halachic death. If the man is indeed halachically dead, there are concerns that result from dealing with a dead body, such as delaying burial, *nivvul ha'met*, and *hana'ah min ha'met*, as will be addressed below. Rabbi Yigal Shafran, Director of the Jerusalem Rabbinat's Department of Medicine and Halacha, prohibits posthumous sperm retrieval due to these concerns [1]. Many modern day poskim, including Rabbi Yosef Shalom Elyashiv, Rabbi Shmuel Vosner, and Rabbi Eliezer Waldenberg concur that the heartbeat must stop; cessation

of breathing (i.e. brain death) is not enough to constitute halachic death [3]. If a brain-dead individual is not considered halachically dead, the sperm procurement procedure may be considered assault on a living person. Moreover, this decision has implications on the parental halachic standing of the child. Some poskim assert that a child conceived utilizing postmortem insemination does not have a halachic father, and therefore the vitality status of the father has an impact on the halachic lineage of the child [1]. The discussions within this article will assume that the father is indeed halachically dead, in accordance with the definition of death of the Chief Rabbinat of Israel under the auspices of Rabbi Avraham Kahana-Shapira and Rabbi Mordechai Eliyahu, who define halachic death as brain death, or more specifically, that all autonomous breathing has permanently irreversibly stopped, which can be proved by lack of function of the brain [3].

There are three major halachic concerns when it comes to the physical extraction of sperm postmortem: delaying burial, the issue of *nivvul ha'met* (prohibition against desecrating the dead) and the issue of *hana'ah min ha'met* (prohibition against benefitting from the dead). Rabbi Chaim David Halevi, Sefardic Chief Rabbi of Tel Aviv-Yaffo from 1972-1998, writes that the mitzvah of burial does not apply to an organ that is going to be transplanted because it will shortly be used within a living body. Similarly, Rabbi Issar Yehuda Unterman, Chief Rabbi of Israel from 1964-1965, opines that a harvested organ returns to life once implanted and therefore is exempted *ab initio* from the requirement of burial [3]. The issue of *nivvul ha'met* is derived from the prohibition against causing damage to another person, and therefore posthumous sperm procurement should be forbidden if it involves any degradation. According to Rabbi Moshe Feinstein, disrespect would occur only if the procedure were to be done any differently on a dead person than on a live patient. If retrieval of the sperm is done in “the correct, dignified manner,” it does not make a difference if the patient is alive or dead, because there is no inherent desecration [4]. A further consideration in the matter is whether consent given beforehand can play any role in permissibility. Rabbi Moshe Schreiber, better known as the Chatam Sofer, a leading Orthodox rabbi of European Jewry in the first half of the nineteenth century, holds that consent does not authorize desecration, because it is not only a personal matter, but also includes the honor of God. Maharam Schick, a leading Orthodox rabbi in nineteenth century Hungary, held similarly, but explained that desecration of the dead is in fact insulting to the living. However, in his Responsa Binyan Tzion, Rabbi Yaakov Ettinger asserts that an autopsy may exclusively be performed if the person specifically waived his own dignity by giving consent while he was still alive [3]. Assumedly, this would not apply exclusively to autopsies, but to any procedure performed postmortem that would involve potential desecration. In the same vein, Rabbi Zalman Nechemia Goldberg, a modern Israeli posek and Chief Justice of Beit Din HaGadol of Jerusalem,

asserts that if there is no consent, the entire procedure is forbidden. However, if explicit consent is given for the procedure, or if it is obvious that the man would have wanted the procedure done, there is no prohibition. As Rabbi Mordechai Halperin, director of the Dr. Falk Schlesinger Institute for Medical-Halachic Research and the Chief Officer of Medical Ethics at Israel's Ministry of Health, stipulates, "As long as the deceased gave his consent, there is strict supervision ensuring that there will be no mixing of sperm, and there is documentation of the child's paternity so that later, when the child is ready to get married, his legal, halachic father will be known," the procedure is halachically acceptable [4].

The issur of hana'ah min ha'met applies to any benefit one could have from a dead body. Therefore, if procuring the sperm is a benefit, it should be forbidden. Rabbi Issar Yehuda Unterman holds that hana'ah min ha'met does not apply "in corneal transplants because the cornea continues to live in the body of the recipient and therefore is not considered dead tissue, and Rabbi Shlomo Zalman Auerbach accepted this argument" [4]. Rabbi Levi Yitzchak Halperin, director of the Institute for Science and Halacha in Jerusalem, posits that based on this notion, insemination should all the more so be allowed because the purpose of the entire process is to create life from the zera [5]. Furthermore, the purpose of the procurement is procreation, which is a mitzvah via the commandment "pru u'revu," to be fruitful and multiply. If indeed the insemination is a means of fulfilling the mitzvah of pru u'revu, then the principle of mitzvot lav lehanot nitnu, that mitzvot were not given to us to benefit from, must be taken into consideration. Rabbi Mordechai Halperin proposes that the procurement can perforce not be considered a hana'ah, because it is for a mitzvah [4]. However, one must also consider that having a child may be a secondary hana'ah that results, and therefore this argument may be invalidated [6]. This requires further investigation that is beyond the scope of this article.

Within halacha, there are two different commandments that ostensibly have identical fulfillments: "Pru u'revu u'mil-eu kol ha'aretz," "be fruitful and multiply and fill the entire land" (Bereshit 1:28), and "Lo tohu ber'ah lashevet yitzrah," "God did not create the world to be desolate, but rather, inhabited" (Yishayahu 45:18). The obvious difference between these two commandments is their sources; pru u'revu is deoraita, directly from the Torah, while lashevet is divrei sofrim, from the prophets. The Gemara in Masechet Megilla 27a, in regard to women's obligation to have children, quotes lashevet. Tosafot (medieval commentary on the Talmud) in Masechet Gittin 41b says that lashevet, in fact, is not the same commandment as pru u'revu, and elucidates two new considerations. The first possibility is that lashevet is not an entirely separate mitzvah, but rather amplifies the mitzvah of pru u'revu, emphasizing its importance. In Tosafot's theory, without lashevet, pru u'revu is a mitzvah regilah (regular mitzvah) like any other deoraita, but lashevet intensifies it and makes it into a mitzvah rabah, a magnified and important mitzvah. The other option is that lashevet is in fact a separate mitzvah and is intended to encompass individuals who are not required to fulfill pru u'revu. Since pru u'revu applies strictly to men, because women cannot be obligated in a mitzvah that can be potentially dangerous, as concluded in Yevamot 65b, lashevet would come to include women. Based on this, we can conclude that women are definitely not obligated in

pru u'revu. But are women obligated in lashevet? If the halacha is like the first option in the Tosafot, women would not be obligated because lashevet is simply amplifying pru u'revu, in which they are not obligated at all, as seen in the Beit Shmuel, a seventeenth century commentary by Rabbi Shmuel ben Uri Shraga Fayvish, on Shulchan Aruch Even HaEzer Hilchot Piryah V'Rivya 1:2. However, if the halacha is like the second possibility, women would be obligated, albeit not to the same degree, because lashevet adds them in. This second approach is held li'ma-aseh by the Mishnah Berurah 153:24, which is a commentary on the Shulchan Aruch published by Rabbi Yisrael Meir Kagan (author of the Chofetz Chaim) in the late nineteenth century [7]. The Magen Avraham, a commentary on the Shulchan Aruch completed in 1671 by Rabbi Abraham Abele Gombiner in Poland, and the Chatam Sofer state that women are obligated (by "lashevet") to populate the world [8]. Moreover, there is a further commandment of "V'La-erev Al Tanach Yadecha" (Kohelet 11:6), which many poskim interpret to mean that one should never stop trying to have children; just as one does when they are young, they should continue to attempt when they are older. This effectively means that the only excuse for stopping to try to have children is, essentially, death [7]. However, a deeper analysis of the applicability of this commandment is beyond the scope of this article.

The reason all of this is important is because it is determining why exactly a wife would want, or if she would even be allowed, to be inseminated with her husband's sperm. If her husband can in fact fulfill the mitzvah postmortem, then there is no issue of hana'ah min hamet because she is extracting sperm to fulfill his mitzvah, whether or not she is obligated in the mitzvah herself. But if her husband cannot fulfill the mitzvah after he dies, the question of whether or not she is allowed to extract his sperm depends upon whether or not she is indeed obligated in the commandment of procreation.

Can the mitzvah of pru u'revu be fulfilled after death? The principle of bameitim chafshi, the dead are free, is discussed in Masechet Shabbat 30a [4]. The Gemara indicates that once people are dead, they are "batel," not required to do mitzvot anymore, seemingly because they physically have lost the capability to do so, and therefore are "free" from doing mitzvot. Therefore, the mitzvah of pru u'revu cannot be fulfilled posthumously, because the man is no longer commanded in it. One proposition to counter this is that actions in life have the capability to reap schar, reward, even after our death, as shown in the principle of "Bera Mezakei Abba," merits acquired by a son affect the father, as seen in Sanhedrin 104a. Can this principle be extended to anything that someone does in this world, and if so, if a person writes a consent form, is this an action of his that can give him reward after death? This is a bit of a stretch, and one would have to assume that he can only continue collecting schar for something that he already initiated in his lifetime. Seemingly, consent is not enough initiation to collect schar later on in his life [6].

After death, a person can obviously not be involved in the ma'aseh of the mitzvah. The Minchat Chinuch, a discussion of the 613 mitzvot by Rabbeinu Yosef Babad based on the Sefer HaChinuch in the mid-late nineteenth century, says that pru u'revu is fulfilled through the existence of children. Therefore, the ma'aseh seems

inconsequential, and it should not matter when the insemination takes place, because the insemination is only the mechanism through which the mitzvah of having a child is achieved. However, as previously established, the father cannot fulfill mitzvot, so any argument that this procedure would somehow benefit him postmortem is moot, and the halachic relationship between the father and child is a separate discussion. Rabbi Shaul Yisraeli, a prominent twentieth century Israeli posek, holds that this child is not a part of the yerushah, and therefore does not free his mother from yibbum, but Rabbi Mordechai Halperin opines there is no proof that the child does not have a halachic relationship [4]. Rabbi Yisraeli ruled that a child conceived through postmortem sperm insemination has no halachic father [1]. An in-depth analysis is beyond the scope of this article, predominantly because of its lack of practical implication on the permissibility of the procedure. Rabbi Mordechai Halperin concludes by stating that “the default

position in Jewish law is permissibility, not prohibition,” as he proves from the Mishnah Yadayim 4:3 which “emphasizes that only prohibitive, strict rulings require juridical substantiation while permissive or lenient rulings need no supportive precedent” [4].

While there are many considerations, each complication has a factor of permissibility, and each individual should consult her own rabbi to discuss any pertinent matters. From a legal standpoint, all issues can be avoided if there is clear, written consent, but from a halachic perspective the issues are obviously much more extensive [9]. There are no easy conclusions about whether or not this procedure is halachically permissible. The motivations are generally not halachic, but rather they satisfy the widow’s emotional need to have a child “with” her late husband. Even if the husband is not fulfilling a mitzvah, per se, in practicality he is indeed a father [6].

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# God Bless You! - Smell and Spirituality

Rebecca van Bemmelen

A study published earlier this year in the journal *Science* revealed that the human nose is capable of differentiating between at least one trillion different odors [1]. The power of olfaction is also acknowledged in biblical tradition, which states that the very existence of mankind began with the nose. The Torah records in Genesis (2:7) that God formed Adam out of earth and “He blew into his nostrils the soul of life, and man became a living being.” Based on this, Kabbalistic sources explain that smell is the only sense a human being possesses which impacts the soul. The power of olfaction is recognized by scientists and Torah authorities, who attribute many qualities to this sense. Both fields believe that fragrances have the ability to evoke memories, help people recognize certain character traits in others, and arouse joy.

Associations between smell and memory are strong, and have been scientifically proven to begin in the womb [2]. The process by which smell evokes memories is through receptor neurons found in the olfactory bulb. The olfactory bulb is linked to the amygdala, the part of the brain responsible for memory and emotions. The amygdala also connects to the hippocampus, which is the brain system responsible for associative learning [3]. These brain centers work together to perceive odors and create conditioned responses, enabling people to access memories which remind them about people, places, or events associated with specific smells. A fetus exposed to volatiles from the mother (such as alcohol, cigarette smoke, or garlic) showed greater preferences for these smells in comparison to infants who had not been exposed [4]. Infants who were exposed to a specific smell formed a memory of it and were therefore comforted when they smelled it again.

Fragrance played a major role in the ketores, incense, of the Temple service, where it was used to evoke memories for God. The Midrash Bereishis Rabbah (34:10) explains that the bringing of the incense reminded God of the willingness of His righteous ones, who are described as pleasant aromas, to enter a furnace for His glory. The incense evoked the memory of Abraham, Hananiah, Mishael, and Azariah who were willing to jump into a fiery furnace in God’s honor. The smell of the incense also reminded Him of the generations murdered because of their devotion to God. By burning incense, the Jewish people hoped to find favor before God by evoking memories of the devotion of their forbearers. In a similar vein, Shir Hashirim Rabbah (4:14) notes that when Joshua led the Jewish people into the land of Israel and circumcised all the males, he offered up the foreskins as a sacrifice. The smoke and smell went up before God like the aroma of the finest incense. At that moment the Holy One declared that if a time should arise in the future when the Jewish people sin, He will remember this aroma and the memory will cause Him to have compassion. Even centuries ago, biblical sources recognized the ability of fragrance to evoke memory.

A second aspect of the sense of smell is the subconscious ability to sense if a person is happy or angry by the aroma he exudes.

Experiments showed that positive moods such as happiness, serenity, and safety have identifiable odors, as do negative moods such as stress and fear [5]. Researchers performed an experiment in which subjects wore underarm pads while they watched movies that induced either fear or happiness. At the end of each movie, the underarm pads were evaluated by a second group of research subjects, who were asked to guess the moods based on the scent of the sweat. The researchers found significant evidence that the induced mood could be accurately detected [5]. Additionally, when the second group smelled the odor pads their facial expressions reflected the mood of the original subject. For example if the sweat was collected when the movie viewer was afraid, the second research subject displayed a facial expression of widened eyes and a dropped jaw when smelling the odor. Thus, researchers noted that there is a connection between mood and body odor [6].

The Torah also suggests that it is possible to differentiate one’s character traits using the sense of smell. The Prophet Isaiah (11:3) said, “[The Messiah] will smell fear of God; he will not judge by the vision of his eyes or rebuke according to what he hears with his ears.” In Tractate Sanhedrin 93b, the sage Rava explains this verse literally: the Messiah will have the ability to use his sense of smell to differentiate between the innocent and the guilty. The Messiah will be able to smell the deeper soul of a person and use that odor to accurately judge if the person has proper fear of God. Thus Biblical tradition places a practical application to the scientific correlation between odor and mood.

A third aspect of olfaction is that the sense of smell is strongly connected to emotions. Research has shown that the effects of some floral odors may achieve the same results as pharmaceutical drugs in treating people suffering from depression. For example, exposure to the smell of flowers has been shown to be superior to antidepressants in affecting neuroendocrine hormone levels and immune function [7]. A pleasant smell has the ability to uplift a person and put one in a better mood.

The Jewish sages recognized the sense of smell as capable of evoking joy. This idea may be seen in the obligation to recite a blessing upon smelling pleasing fragrances. The Talmud in Tractate Brachos (43b) notes “How do we know that one should make a blessing over pleasant fragrances? For it says, [Psalms 150:6] ‘Let all souls praise G-d’. What thing does a soul enjoy that a body does not? Only a good smell.” Additionally, the Sabbath day is very intertwined with the concept of joy and fragrances. Tractate Shabbos 119a related a story in which Caesar once said to R. Yehoshua ben Chananya, “Why is it that the food cooked for the Sabbath has such a strong aroma?” R. Yehoshua answered him, “We have this one spice, it is called Sabbath, which we throw into the Sabbath food, and its aroma is very penetrating.” The day of Sabbath is metaphorically described as an aroma because just as a pleasant aroma brings joy to the partaker, the Sabbath is meant to be a day of joy. There is also a tradition for Jews to make a blessing

on besamim (spices) as the Sabbath departs, since the fragrant smell of the spice comforts and soothes a person as he leaves behind the holiness that surrounded him on the Sabbath. The Torah recognized the ability of smell to create a joyous mindset and developed this idea in religious rituals.

Science and Torah both support the idea that olfaction serves a number of roles, such as the ability to evoke memories, to differentiate between personalities, and to arouse joy. Rabbi Zvi Elimelech Shapiro of Dynov, author of the Chassidic work Bnei Yissaschar, points out that when Adam and Eve ate from the Tree of Knowledge, all of their senses were involved and were

damaged except for the sense of smell. Eve sinned by listening to the snake with her ears, viewing the tree as “a delight to the eyes” (Genesis 3:6), taking from the tree with her hands, tasting the fruit with her mouth, and convincing Adam through speech to eat the forbidden fruit as well. Only the sense of smell was not involved in the sin, and therefore it retained a pure connection to God and spirituality. Scientific sources similarly report that the sense of smell has a unique connection to the brain and emotions. These modern scientific studies on the olfactory system add to our appreciation of the divine wisdom found within Jewish texts, written thousands of years ago yet still relevant in our time.

---

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# Colors of Judaism

Emily Chase

On the first day of creation, G-d created light, as it says in Bereishit 1:3, “And G-d said let there be light and there was light.” Science reveals how this visible light, composed of electromagnetic waves, relates to color perception. When an object appears to be a certain color, it is reflecting the specific wavelength that corresponds to that color and at the same time absorbing all the other wavelengths. Our eye distinguishes between different colors through the use of photoreceptor cells known as cones. The three types of cones are called the red, blue, and green cones, each named for the corresponding range of wavelength that activates them. It seems that the Torah knew of this distinction as well. Rav Samson Raphael Hirsch, a major rabbinic leader in Germany in the late 1800s, asserts that there are only three Hebrew names given to colors within the spectrum of light: red (*adom*), yellow/green (*yarok*), and blue/violet (*tekhelet*) [1]. This article will discuss the relationship between Torah and science with regard to each of these colors.

The red color detected by the cones has halachic significance in that women are forbidden to wear red garments according to Shulchan Aruch, Yoreh De’ah 178:1. At the end of Bereishit, when Yaakov blesses his sons, he describes Yehudah with the words “He washes his garments in wine and *suto* in the blood of grapes.” (49:11). Rashi comments that “*suto*” could mean “colored things,” explaining that a woman wears “*suto*” as a means to entice a man to look at her. Based on this, it seems that rabbinic thought at the time believed the color of wine to be associated with lust and earthly desires. Rav Hirsch hints to the fact that the word red (*adom*), man (*adam*), and earth (*adama*) originate from the same root word, indicating that the color red is connected to earthly matters [1]. Science has also proven that red is an enticing color. In a recent study, some participants were shown pictures of women wearing red shirts, and others were shown pictures of women wearing a color other than red. The study found that men perceived women wearing red as more attractive and sexually desirable than those wearing the other color. The study advises: “Our results suggest that women may need to be judicious in their use of red clothing...a red signal may result in unwanted sexual advances” [2]. Another study found that the link between red and romantic attraction was not only observed in the US and Europe, but it was also observed in culturally isolated societies [3].

The color red also relates to *niddah*, a woman’s laws of purity. Rabbi Mordechai Halperin, the Chief Officer of Medical Ethics for the Israeli Ministry of Health, discusses this issue in relation to color blindness in males. He quotes the Mishnah Niddah (2:6) in saying that there are five kinds of blood that make a woman *niddah*: “red, black, the color of a crocus, the color of earthly water, or like dilute wine.” He then quotes the Gemara (Niddah 19-20), which says that initially Rabbi Yohanan was examining blood stains, but he stopped because the stains he thought looked *tahor* were being

classified as *tameh* by Rabbi Hanina. Rabbi Mordechai Halperin then cites the explanation of Rav Saadia Gaon, which says that nowadays, rabbis only declare a color clean when it does not tend to redness at all, referring to colors such as white or golden green. Based on this, Rabbi Halperin declares that this “absolute decree...” covers the problem of varying degrees of color blindness.” In this way, even rabbis with color blindness are able to make decisions in matters of *niddah* [4]. It seems that the rabbis were aware of color blindness and tried to work around the issue. This would have been important in olden times, when perhaps there was only one rabbi available for consultation in each village.

The cones are also sensitive to the color green, which is known to be pleasing, and this comes into play in the story of Esther. The Gemara (Megillah 13a) gives many reasons as to why Esther was called Hadassah in Esther 2:7. Haddas is a myrtle, and R’ Yehoshua ben Korchah explains that Esther had a greenish complexion (Megillah 13a). The Gemara continues by saying that she was given a touch of grace by G-d (Megillah 13a), and this can be seen from the megillah’s descriptions of her beauty, which uses words such as *yifat toar* and *yifat mareh* (Esther 2:7). Furthermore, when all of the beautiful young women were assembled before the king, Esther was the one who found favor in the eyes of the king and all who saw her (Esther 2:15 and 2:17).

If R’ Yehoshua ben Korchah’s words mean that Esther actually had a greenish tinge to her skin, we can scientifically explain the appealing effect of her complexion. The current scientific view of the color green is that it is a calming, relaxing color. Andre Elliot, a professor of psychology at the University of Rochester was quoted as saying, “There is some tentative evidence that green is relaxing because it is associated with growth and nature” [5]. Perhaps the relaxing effect has something to do with green light having a shorter wavelength than that of red light. One study measured people’s psychological responses to trees of different colors and found that bright green trees were considered more calming than trees of other colors [6]. Another study showed that subjects who were told to wait in a red room had higher stress rating scores than those who waited in a green or white room [7]. Based on this, perhaps Esther’s greenish tinge, instead of the normal pinkish tinge, was calming and pleasing to the people who saw her. This reasoning would help explain why she was chosen by Ahasuerus to be queen.

The third type of cone perceives the color blue. The Torah discussion regarding the color blue centers around the word *tekhelet*, a biblical blue dye which has been lost from Jewish tradition for many years. This dye is mentioned in the Shema prayer, as it is written, “And they are to place on the *tzitzit* of each corner a thread of *tekhelet* (Bamidbar 15:38). According to the Torah, part of the *tzitzit* should be dyed with the *tekhelet* color. The Gemara describes the color of the *tekhelet* as “similar to the sea, and the

sea is similar (in color) to the sky” (Menachot 43b). The next verse of the Shema reads “And it will be for you tzitzit and you will see it (oto) and you will remember all the mitzvot of Hashem” (Bamidbar 15:39). Rashi explains that the gematria (numerical value) of tzitzit is 600. Then the eight strings of tzitzit adds 8, and the five knots of tzitzit adds 5, equaling a total of 613, a number which corresponds to the 613 mitzvot. According to Rashi, this could be the reason why looking at tzitzit would remind someone of the mitzvot of G-d.

P’ Til Tekhelet Association is a non-profit organization that provides educational resources about tekhelet and produces what it claims to be the true tekhelet dye. One of the founders of this organization, Dr. Baruch Sterman, wrote an article about tekhelet in which he discusses various topics, including the meaning of tekhelet. He quotes the Rashi that we saw in the previous paragraph with regard to the gematria of tzitzit, and he then cites the Rambam who disagrees with Rashi. The Rambam says that צִיִּצִית is not spelled in the Torah here with an extra yud, and therefore the numerical value of tzitzit is only 590. Dr. Baruch Sterman also points out that “oto” in the pasuk is masculine and therefore cannot be referring to tzitzit, which is feminine. He then quotes the Rambam who states, “Rather the remembrance is through the thread of tekhelet ... for the tekhelet is similar to the sea and the sea is similar to the sky and the sky is similar to G-d’s holy throne.” Dr. Baruch Sterman explains the Rambam to mean the following: The sky reminds us of the Infinite, which then reminds us of His commandments. He then brings in a scientific study by scientists J. Wouters and A. Verhecken who examined the dye obtained from the Murex trunculus snail. According to the P’ Til Tekhelet Association, this is the snail that produces the true tekhelet dye. Interestingly enough, the largest absorption of light was recorded at a wavelength of exactly 613 nanometers. This could be another explanation as to why looking at the tekhelet would remind a Jew of the mitzvot [8,9].

Rav Hirsch also examines the color blue. He explains that the Cohen Gadol wore tekhelet, while the ark, table, menorah, altar

of incense, and other utensils of the Sanctuary were covered with a fabric of tekhelet. He describes how the threads of tekhelet were used to connect objects for the Sanctuary. The root word of tekhelet, according to Rav Hirsch, is kalah, and therefore the literal meaning of tekhelet is “the end.” Rav Hirsch explains that tekhelet could be a violet color and comments on how the spectrum of visible light stops after the violet color. He also notes that, “additional wavelengths of light radiate unseen beyond the visible spectrum.” He explains the symbolism of tekhelet based on the following: “Likewise, the blue expanse of the sky forms the end only of the earth that is visible to us. And so, tekhelet is simply the bridge that leads thinking man from the visible, physical sphere of the terrestrial world into the unseen sphere of heaven beyond.” He explains that the primary color of the Sanctuary was blue-violet to represent the law that was given to us by G-d, who is “beyond the limit of physical visible matter.” The Sanctuary is associated with something G-dly, and therefore it is given the color of tekhelet [1]. The blue-violet light he describes as tekhelet has the shortest wavelength of the visible light spectrum, which also means that it has the highest energy. On the opposite end, red light has the longest wavelength and therefore the lowest energy of the spectrum. If, like Rav Hirsch, we view blue as a G-dly color and red as an earthly color, then the physical energy inherent in the colors would directly correlate to the spiritual level associated with them.

From these examples, we can see how the ideas in Torah and science work together to create a total picture of the complex meanings behind these colors. With respect to many of the properties of red, green, and blue, the ideas in Torah and science complement one another. Behind many of the colors around us are shades of both psychological and metaphysical meaning. Understanding the depth of the colors we see around us every day allows us to appreciate the depth with which G-d created the world. During the creation of the world, Rashi explains, the primordial light was hidden for the righteous people in the future. May we merit to one day see this light in all of its colors.

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# Halachik Considerations of IVF

Tehila Feinberg

The treatment options offered by the use of in vitro fertilization (IVF) present difficult halachik questions. This modern day issue has obliged our poskim to address the freezing of oocytes both for immediate re-implantation as well as to set aside oocytes for women who may choose to have them fertilized and re-implanted at a later date [1].

The American Society of Reproductive Medicine (ASRM) defines infertility as “a disease defined by the failure to achieve pregnancy after twelve months or more of regular and unprotected intercourse.” According to the ASRM, “earlier evaluation and treatment is warranted after six months of a woman over age thirty-five” [2].

Statistically, there is a clear decline in fertility as women age. Six percent of women in their early to mid-twenties are infertile, and nine percent of women in their late twenties cannot conceive. Fifteen percent of women in their thirties are infertile, and thirty percent of women in their late thirties cannot have children. Sixty-four percent of women in their forties no longer have the ability to conceive [3,4].

The process leading to IVF involves the determination of the source of the infertility. Physical examination, medical history, and a series of tests are administered to establish its cause. Once IVF has been chosen, stimulants promoting ovulation are prescribed. The reproductive endocrinologist will harvest follicles by needle aspiration; this may require local anesthesia or a sedative. The harvested follicles are frozen and will be re-implanted when fertilization is complete. This procedure is performed on an ambulatory basis. “A 0.08 to 0.7 percent incidence of intra-abdominal bleeding requiring surgical intervention, abscesses, ovarian torsion, cyst rupture, [and] severe ovarian hyper stimulation syndrome” are listed as the most common complications related to this procedure [5].

With age, the fixed number of oocytes with which a woman is born will have been exposed to insults, which compromise the integrity of the DNA. This increases the probability of chromosomal abnormalities, resulting in aneuploidy, which is a category of chromosomal defects involving particular genes or chromosomal regions present in extra or fewer copies of chromosomes than in a normal set of chromosomes. There is close to a one hundred percent statistical probability that a woman conceiving at or beyond the age of 45 will have a child with chromosomal abnormalities [6,7].

The process of IVF seems like a positive solution for women having difficulties conceiving children, but is it halachikally acceptable? Two halachik points are addressed regarding use of

IVF. The first issue is sakana, or self-endangerment, and the second issue is chavala, inflicting injury upon oneself.

The issues regarding sakana are complex. We are taught in Exodus that the source for doctors to intervene and heal a person is “verapoh yerapeh”, and they shall heal. As previously stated in this article, the ASRM classifies infertility as a disease. Since the medical establishment has labeled infertility as a disease, it should be halachikally permissible to seek out treatment for infertility.

The Rambam questions medical sakana by asking if one can undergo elective procedures despite an inherent risk [8]. The Avnei Nezer replies that it is forbidden to do so, and further more prohibits any non-lifesaving surgeries, arguing life-threatening risks [9]. On the other hand, Rav Breisch and Rav Moshe Feinstein agree that elective procedures are permitted under specific circumstances, and this is expressed in their teshuvot regarding the permissibility of cosmetic surgeries [10,11]. Rav Feinstein evokes the concept of shomea petaim HaShem, which is the idea that you can rely on God to protect and save you from risks you are facing, as long as it is in accordance with the social definition of acceptable risks [12].

The Torah and Talmud are extremely sensitive to women’s infertility and potential adverse effects it may have on marriage, specifically on the ketuba as well as yibum and chalitzah. Rav Moshe Feinstein also appreciates the need for an unmarried woman to secure her future as a mother and therefore allows her to freeze her oocytes.

One might argue that in terms of chavala, elective surgeries could be viewed as inflicting injury onto oneself. In Deuteronomy 21 we are given the prohibition of self-injury, which is further developed by the Tractate. Does this commandment apply to elective surgeries? Rav Moshe Feinstein categorizes elective surgery as removing a psychological pain. He interprets self-injurious behavior as something being done aggressively, derech nitzayon or derech bizayon.

To address the issue of psychological pain, Rav Breisch differentiates between two types of pain: letzorech, for monetary gain, which is forbidden, and tzaar, to improve one’s self-esteem, which is permitted [13,14].

Rav Breisch comments on the issue of embarrassment in relation to elective surgeries. Tosfot states that if a person suffers from psychological but no physiological pain, they can treat their condition [15]. Rav Breisch addresses an individual’s imperfections, acknowledging that this can bring a great deal of pain and embarrassment. This line of thought may lend support to the idea that IVF can help a patient attenuate the anguish of experiencing difficulty in conceiving a child.

Unlike Rav Breisch and Rav Feinstein who endorse IVF, Rav Eliezer Yehuda Waldenberg staunchly opposes it [16]. He interprets the process of IVF as rejecting the divine model HaShem instilled in each human. Each person was created “Betzelem Elokim,” in the image of God. According to Rav Waldenberg, this concept is so important that no one should intervene with the way God created an individual, and even a person’s imperfections should not be changed.

Rav Waldenberg expresses a few concerns in regard to IVF. One issue is the waste of sperm, which is an outright prohibition from the Torah [17]. Artificial insemination is only permitted when treating male infertility, and IVF is a treatment for women’s infertility. A second concern is the involvement of a third party when creating a child. He views the interference of doctors as unnatural and concludes that a man does not satisfy his rabbinic and biblical obligation to procreate when conceiving in this manner [18]. Rav Waldenberg perceives the zygote as a processed specimen entering the woman’s uterus. Another concern is that IVF can lead to more complex issues, such as cloning, so this experimental process needs to be stopped before it advances to further manipulations.

Rav Avigdor Nebenzahl raises several issues with Rav Waldenberg’s teshuva [19]. He questions the effects of denying a couple the opportunities to undergo IVF and the marital stress which may ensue. Rav Nebenzahl addresses the issue of fulfilling the commandment of “pru urvu,” to be fruitful and multiply. He views the process of IVF as equivalent to normal conception and states that it satisfies the commandment of “pru urvu.” Finally, he suggests that the halachik and personal need to procreate overrides the risks of cloning.

Rav Ovadia Yosef and Rav Elyashiv permit the use of IVF only given that the sperm donated must be used, IVF must be undertaken as a last resort, and there must be strict supervision of the gametes [20,21,22].

Almost four decades after the first IVF live birth, a majority of poskim recognize this procedure as an acceptable last resort for women unable to conceive naturally, given that the wife’s oocytes and the husband’s sperm are used. However, many poskim continue to view the use of donors in the process as problematic.

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# The Epigenetics of Children of Holocaust Survivors

Talia Felman

While the number of living Holocaust survivors continues to dwindle, the damage that the Holocaust has done does not. The scars remain not only among the Holocaust survivors themselves, but also among their children, often called second-generation Holocaust survivors, and their grandchildren. It has long been known that the trauma endured by those who went through the war can be transmitted through environmental factors to second and third generations in a psychological manner. For instance, survivors have often displayed symptoms of what psychologists now identify as posttraumatic stress disorder (PTSD). Thus, their children grew up in homes where it was normal for the parents to display PTSD symptoms, which include irritability, mood swings, jumpiness and hyper-vigilance. As a result, the children of survivors often have terrifying worldviews, a lack of rootedness and belonging, experiences of guilt, victimization and submission, and a fear of being recognized by external identities [1]. Scientists are now discovering that this sort of psychological transmission is only one way that the experiences of the Holocaust are passed from generation to generation.

More recently, it has become clear that this transmission does not just have a psychological basis, but an important hereditary component as well. Psychological transmission, as opposed to genetic heredity, does not sufficiently explain how experiences stored in the unconscious minds of survivors can be transmitted biologically to their child. Thus, scientists are beginning to take a much closer look at the kind of trauma passed on to second-generation survivors, and how such trauma is transmitted. To do this, the concept of epigenetics has been introduced into research concerning transgenerational transmission of trauma (TTT). Genetic mechanisms can explain how gene sequences are passed from parents to their children, however, they do not answer the question of how and why gene expression and regulation can vary from parent to child [2]. Epigenetics is concerned with changes to gene expression, the process by which genetic information directs the synthesis of proteins and nucleic acids. Changes in gene expression can be caused by methylation, the addition of a methyl molecule to DNA, and can occur in response to environmental factors including trauma and stress. Those changes can then be transmitted intergenerationally, leaving the children of survivors with gene expression that is uniquely influenced by the experiences of their parents [3]. In the context of Holocaust studies, epigenetics is being summoned to shed light on how second-generation Holocaust survivors may experience the repressed memories or nightmares of their parents, easily imagining the hunger and sounds of the war, and leaving them much more predisposed to developing PTSD symptoms of their own.

An early study that provided the basis for exploring the epigenetic transmission of PTSD involved separating mice, ages 0-14 days, from their mothers at unpredictable and varied lengths of time.

The mice were subsequently reared normally until adulthood. Once mature, the mice showed PTSD symptoms of isolation and jumpiness, while the control group, consisting of mice who were reared normally, did not. Moreover, the study focused on five genes that regulate behaviors involved in the response to stress. All of these genes, including both the gene involved in corticotropin-releasing factor (CRF) regulation and the one involved in serotonin regulation, which are both hormones implicated in the stress response, proved to be either over- or under-active. These mice are analogous to first generation Holocaust survivors. The first generation males fathered young, and had little to do with the rearing of their pups. Yet, their offspring, who were reared normally by their mothers, exhibited anxious behavior similar to that of their fathers, and had the same unique gene changes. This correlation shows that epigenetic changes can occur very early in life even in the absence of exposure to the one from whom the trauma stems. This experiment serves as the model for experiments on humans that cannot be as precisely controlled [4].

A similar effect was seen in humans several years after the events of 9/11. Mothers who were pregnant and present at the collapse of the World Trade Center developed PTSD in the aftermath of their experiences. When compared to mothers who did not develop PTSD in response to the attacks, the mothers who exhibited PTSD symptoms showed lower levels of cortisol, a hormone involved in the regulation of stress, in their saliva samples. Interestingly enough, their babies also showed lower cortisol levels relative to the offspring of mothers who did not develop PTSD. The difference was most pronounced in mothers and babies who were exposed to trauma in the third trimester of pregnancy. This data suggested that perhaps trauma can even affect the epigenome of an unborn fetus. Moreover, this study is significant because it suggests that the effects of maternal PTSD related to cortisol levels can be discerned early in the lives of her offspring and can contribute to the risk factor of PTSD in their children. Furthermore, it highlights the epigenetic mechanisms at play, as it is not a defective gene that is transmitted, rather it is the expression of the gene that changes intergenerationally [5].

Another study investigated the effects of maternal PTSD, paternal PTSD, or both on second-generation survivors. This study focused on the methylation of very specific area of DNA, particularly the exon promoter (1f) glucocorticoid receptor (GR-1f) gene (NR3C1), which is the receptor to which cortisol and other glucocorticoid hormones bind. After undergoing clinical interviews and self-report measures, blood samples were collected from offspring of survivors with PTSD and compared with samples from adults without parental PTSD or Holocaust exposure. The samples were analyzed for GR-1f promoter methylation and cortisol levels. Results showed that maternal PTSD increased the risk for PTSD and paternal PTSD (when in the absence of maternal PTSD) enhanced the

risk of depression in offspring. Further analysis showed that both maternal and paternal PTSD correlated with certain psychological characteristics in children, and lower GR-1f promoter methylation was associated with maternal PTSD [6].

Epigenetic transmission of Holocaust trauma can also affect the eating habits of offspring. There have been reports of the prevalence of eating disorders and anxiety in third-generation survivors [7]. There may be a precedent for this in studies done on people who experienced the Dutch Famine in 1944-45 in the Netherlands. These studies showed that exposure to acute, severe famine during pregnancy influenced the birth weights of those born during the famine and, through a phenotypic, or observable, response, that of their offspring [8]. It has been suggested that the

same phenomenon may have affected the offspring of Holocaust survivors.

As epigenetics is a relatively new field of research, there is much further study that can be done. For example, the exact mechanisms of TTT are still unknown. Additionally, the difference between children born immediately after the Holocaust and decades after has not yet been addressed. Are the effects the same if the exposure to PTSD is prenatal or postnatal? Can the epigenetic effects of trauma be transmitted to third and fourth generations as well? If so, are they affected to the same degree? Questions like these and many others are still unanswered, but recent discoveries have laid a great deal of significant groundwork for continued study in this area.

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# The Eighth-Month Conundrum

Rebecca Garber

**S**afely resting in the amniotic sac and connected to an umbilical cord, a baby stays cushioned in its mother's protective and nurturing womb for 37 to 40 weeks. The closer the baby's birth is to 40 weeks, the better chance it has to be healthy and strong. Any baby born before the 37-week mark is said to be premature, which, according to the Centers for Disease Control, happens in about 12 percent of pregnancies [1]. Today, the leading cause of infant death is premature birth. Although surviving premature babies are likely to have intellectual disabilities, as well as breathing, visual, hearing, feeding, and digestive problems, at the end of the day, their survival rate is higher than ever [2]. Modern medicine has advanced to such a degree that a baby born before 30 weeks and weighing only two pounds has a chance to survive. Amazingly, some hospitals have been able to save infants born at 22 weeks and weighing less than one pound [2]. With treatments such as high frequency ventilation, fetal diagnosis and therapies, and interdisciplinary management of surgical, premature, and sick neonates, these infants are being given the best care possible [1].

In contrast, fetal vitality in the ancient world was significantly lower, unsurprisingly, due to the lack of modern resources. Much of what is known about fetal vitality and development during the ancient world can be found in the Hippocratic corpus, a book attributed to Hippocrates that is a compilation of ancient medical writings. In the Hippocratic corpus, there is a section called *Peri Oktamenou* (On the eighth-month fetus). In this section, an interesting and unusual phenomenon was reported, namely, that eighth-month fetuses did not survive.

The idea of the non-viable eighth-month fetus was largely accepted in the ancient world. Of all the infants which survived childbirth, only those that were born during a seven or nine-month gestation were believed to be viable [3]. A group of modern physicians from the Department of Obstetrics and Gynecology and Mathematics at Ohio State University traced the sources and validity of this phenomenon after various women from different cultures came to their practice and insisted on giving birth early in the seventh month so as to not give birth in the eighth month. These doctors were intrigued: After all, the longer a premature infant is in the womb, the better. Why would an eighth-month fetus have lesser chance of surviving than a seventh or ninth-month fetus?

These physicians traced the start of the eighth-month phenomenon to Hippocrates. They hypothesized that since Greek culture was widely spread throughout the world, the philosophy of Hippocrates was disseminated as well because he was a prominent Greek physician. Hippocrates' mention of this odd occurrence was enough to spark an interest in many of the prestigious Greek and Roman scientists and philosophers of his time. As more people began to philosophize and hypothesize, the topic generated more interest and the concept gained more credence [4].

The more the idea spread, the more people began trying to explain

it. Rather than believing this phenomenon was due to a physiologic condition, people started offering mythological, numerological, and astrological theories to explain this counter-intuitive notion. For instance, some ancient philosophers placed great importance on the number seven and believed that newborns associated with the number seven lived. The amount of days in seven months (210) and nine months (280) is divisible by seven, while the number of days in eight months (240) is not. Proclus Lycaeus, a Greek Neoplatonist philosopher, believed that humans, unlike animals, have two periods of gestation - seven and nine months - and any baby born during these two times would be viable [5]. Consequently, Proclus believed that if any eighth-month fetus survived, it was only because the child was, in fact, a seven or nine-month-old infant since it was utterly impossible for an eighth-month infant to survive [4].

Pseudo-Philo, the name commonly used for a Jewish work in Latin written during the second century CE, discussed the Jewish tradition regarding the eighth-month fetus and attributes it to divine decree. Pseudo-Philo mentioned that since Yitzchuk Avinu was born in the seventh month, G-d was essentially setting up a "divinely backed viability." In addition, Bereishis Rabbah (24: 2) also discussed the eighth-month fetus. Someone once asked Rabbi Abbahu how it was possible for a seventh-month fetus to be viable. Rabbi Abbahu replied, "Live seven--Go eight." He explained that the Greek word for live, *zito*, has the letter zeta, which has the numerical value of seven. *Go*, which is a euphemism for death, is Greek for *ito*, which is written with letter eta. Not surprisingly, the numerical value of eta is eight. From here it can be inferred that the rabbis of the ancient world were affected by the philosophies of their time and relied heavily on the Greek language and science to explain different occurrences [5].

Ultimately, the notion regarding the eighth-month fetus evolved into acclaimed Western European thought and influenced Rabbinic literature. Even the Talmud mentioned the eighth-month fetus. For instance, the Gemara in Shabbos (135a) also seems to ascribe to the notion regarding the non-viability of the eighth-month fetus. The eighth-month fetus was termed a "naphel" (literally a fall or miscarriage) that ultimately died soon after birth. As such, a baby born in the eighth-month of gestation would not have been circumcised on Shabbos since it was assumed the child was already a corpse and, therefore, there was no *mitzvah* of circumcision. In contrast, a baby born after a seven or nine month gestation can be circumcised on Shabbos. The Talmud continues by noting that the child was *muktzah* and may not be carried on Shabbos. Therefore, the baby born in the eighth month may not even be nursed, unless the mother is in pain due to the stored up milk [6].

The eighth-month baby is also discussed in the topic of *yibbum*, the biblical commandment that requires a widowed woman to marry her deceased husband's brother if she never had a child with her late husband. The Talmud discusses whether or not a woman who gave birth to an eighth-month baby was obligated to perform

this mitzvah. Ultimately, the Talmud concludes that the woman is indeed required to perform yibbum; he was considered childless since the eighth-month old child was considered not viable [5].

Moreover, if there were ever a doubt as to whether a child was born in the seventh or eighth month of pregnancy, it was assumed that the child was born in the eighth month and, therefore, he was not circumcised on Shabbos. Others, like the Tur, argued that a bris may be performed on an infant whose birth month is questionable since performing m'lacha for a bris (i.e. carrying the supplies or sharpening the knives), not the actual bris, was forbidden. The Ramah noted that no m'lacha may be performed for this fetus, even if it is done to save its life [6].

In the Talmud, at the end of Yevamos (80a), Chazal make reference to a "ben shemonah," a fetus born at eight months, which is considered to be "dead flesh" or "like a stone." In this beraisa, Chazal imply that a fetus born in the eighth month was not viable. As such, a non-viable fetus would be considered muktzah [7].

The Talmud (Yevamos 80b) continues by stipulating the conditions that rendered a fetus non-viable. If a fetus was born with underdeveloped hair and fingernails, it was assumed that the fetus would not survive, since complete development of these physical features signified that the baby was strong and healthy enough to survive. When a newborn baby had hair, it was a sign that the child has enough energy and life-force for its body to spare the extra energy to develop hair [8]. A biblical example of this practical concept can be seen through Yaakov and Esav. Esav, the hunter, who was the tougher and more robust of the two, was covered in hair, signifying his physical strength and good health. The passuk reads "and the first came out red, all over like a hairy garment, and they called his name Esav" (Genesis 25:25). Yaakov, however, was a man of the tents and was significantly weaker than Esav, as noted, "And the boys grew, and Esav was a cunning hunter, a man of the field; and Yaakov was a plain man, dwelling in tents" (Genesis 25:27). It is actually believed that Yaakov and Esav were monozygotic twins who suffered from twin-twin transfusion syndrome, a condition that may affect twins within the same amniotic sac and causes them to receive an unequal amount of oxygenated blood. One fetus receives the oxygenated blood from the mother, while the other receives whatever oxygenated blood remains from his twin. As a result, one twin is larger, redder, and

more hairy at birth and the other is smaller and paler. So, it is possible to conclude that the lack of development of hair on a fetus alluded to its weakness [9].

The problem with accepting the concept that the eighth-month fetus was not viable is that people in the ancient world were not experts at determining fetal age. According to modern medicine, the pregnant woman's last menstrual period determines the gestational age of the fetus. However, the ancients believed that gestational age was based on the timing of conception, which they believed could be felt by the woman. Others subscribed to the notion that infant size could determine gestational age. Therefore, even though a seventh-month fetus was actually small for gestational age (SGA) due to improper nourishment, it was, in reality, a full-term nine-month fetus. That is to say what was actually a ninth-month fetus was assumed to be a seventh-month fetus because the fetus was smaller than usual. Since SGA babies have birth weights below the tenth percentile for normal gestational age, it makes sense that their small size led people to believe they were premature. Therefore, an eighth-month fetus, in accordance with the SGA theory, would be larger than a seventh-month fetus. Even if the eighth-month baby were smaller than the seventh-month baby, the ancient physicians would assume that the bigger one was the older one. So, how did premature seven-month-old babies survive? The answer is that they were not seven-month-old babies. They were, more likely, improperly nourished eight or nine-month-old fetuses [5].

Fundamentally, these two theories explain how the majority of eighth-month fetuses did not survive: They were not necessarily eight-month old fetuses. If the fetus did not survive, people simply attributed the death to the unfortunate coincidence of the child being born during the eighth month of its gestation. As time progressed, the trend of non-viability in eight-month fetuses disappeared [4]. As modern medicine advanced, it was easier to determine the actual gestational month of the fetus and to apply interventional measures as needed [2]. In the end, it is interesting to note that the halacha made use of the scientific and philosophical debates of its day. While the majority of the Jewish tradition is based on the written law, there is an aspect that deals with modern developments and current day events. Although the Torah will always remain the same, halacha will develop and grow alongside the changes of the world. As a result, Torah and halacha will always be relevant and necessary in everyday life.

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# Mitochondrial Replacement Therapy and Jewish Law

Sima Grossman

**M**itochondria, energy-producing organelles in cells of the human body, float in the cytoplasm, a liquid substance located externally to the nucleus. The main function of mitochondria is to metabolize sugar and fats and transform them in the process of oxidative phosphorylation into a usable form of cellular energy. The energy produced by this process is stored in the form of the molecule adenosine triphosphate, or ATP. The cellular energy released from hydrolysis of bonds of ATP molecules is subsequently used to power metabolic processes. Since most metabolic processes require an energy input, mitochondria are crucial for sustaining life. There are hundreds to thousands of mitochondria in every cell of the human body [1]. Within each mitochondrion is a circular double stranded DNA, known as mitochondrial DNA (mtDNA), containing 37 genes. These genes are in addition to the 25,000 more commonly discussed genes, which are located on nuclear DNA (nDNA), found on the 23 pairs of chromosomes in the nucleus of a cell. Nuclear DNA determines the traits of a person, such as eye and hair color. Mitochondrial genes, on the other hand, are responsible for the production of enzymes that are crucial for carrying out oxidative phosphorylation, in addition to producing rRNA and tRNA, needed for protein production [2]. Although both eggs and sperm contain nDNA and mtDNA, when a sperm penetrates an egg during fertilization, only the sperm's nDNA enters the egg cell while its mtDNA does not. Therefore, the child produced from the fertilized egg inherits nDNA genes from both of parents but mtDNA only from the mother [3].

Mutations, alterations in DNA that occur spontaneously or that are induced by environmental agents, may be passed on from parent to child. Mutations in nDNA as well as mtDNA can be the cause of many mitochondrial diseases. Mutations in nDNA can affect the maintenance of mtDNA and thereby cause mitochondrial diseases [3]. Mutations in mtDNA can cause diseases as well. The rate of mutation of mtDNA is much higher than the rate of mutation of nDNA. The proportion of damaged mtDNA to undamaged mtDNA is what is significant in determining whether a person will suffer from a mitochondrial disease. Therefore, if a woman carries a small proportion of mutated mtDNA, she is asymptomatic and may therefore be unaware that she is carrying a potential disease. Her offspring, on the other hand, may possibly inherit her mtDNA in different proportions from her and even from each other. They therefore may have various degrees of a mitochondrial disease, that can range from mild to severe, as it is the balance between mutant mitochondria and normal mitochondria that determines the disease outcome [4]. Furthermore, the percentage of mutated mtDNA also determines when symptoms of mtDNA mitochondrial disease will first appear. If a person has a high proportion of mutated mtDNA, symptoms of disease will present themselves early in life. A person with a smaller percentage of abnormal mtDNA may not have the disease or may exhibit a milder form or develop symptoms later in life [5].

Mitochondrial diseases involve a chronic loss of cellular energy. Problems caused by mitochondrial diseases include neurological damage, heart disease, and blindness [6]. Severe forms of mitochondrial disease are very debilitating and some are even lethal. Since mitochondrial diseases are caused by mutations present in every somatic cell, they have no cure. Diseases such as diabetes or external environmental factors can also induce the occurrence and severity of mitochondrial diseases. For example, medications used in chemotherapy can induce mutations in mtDNA. Pollutants, such as tobacco smoke, have also been implicated in causing these mtDNA mutations [5]. In the United States it was estimated that 4,000 children a year are born with mtDNA diseases and few live into adulthood [6]. These diseases affect Jews as well as non-Jews. Some rare mitochondrial diseases have been found to be more prevalent in Ashkenazi Hungarian Jews and in Persian Jews [7].

Researchers are investigating ways to eliminate mtDNA-based diseases. Work is being done on a groundbreaking technique called mitochondrial replacement therapy. This new procedure, which aims to eliminate mutated mtDNA in a fertilized egg cell, involves a woman with mutant mitochondrial genes (woman A), a donor woman with normal mtDNA (woman B), and a father. Woman A is the individual seeking to conceive a child free of mtDNA-based disease. An egg is extracted from the donor woman (woman B) and its nucleus is removed, leaving only an enucleated egg with normal mitochondria. An egg is taken from the woman with the mutated mtDNA (woman A). The nucleus of this egg is then removed and inserted into the enucleated egg of woman B. The resultant egg contains the nDNA of woman A and mtDNA of woman B. This egg, fertilized by the father's sperm, forms a zygote which undergoes a few mitotic divisions and then is implanted into the uterus of woman A. In the United States this procedure was successfully performed on rhesus monkeys in 2009. The monkeys that were born after this procedure appeared normal. In 2012 a human embryo was created with this technology, but was not implanted because the Federal Drug Administration (FDA), the agency which has authority over all reproductive issues, had not, as yet, approved this procedure. The FDA is currently conducting studies on this technology but has not ruled on whether to approve this procedure for the humans [8]. In February 2015 the British House of Commons, as well as the House of Lords, approved this procedure by a wide majority. However, a licensing process must first be drafted which will determine who will be approved for this revolutionary treatment. Each application will then be analyzed and evaluated on its own merits. By 2016, the world may see the first human baby born through mitochondrial replacement therapy [9, 10]. Technically, such a child has three parents: the father, the woman who donated her mtDNA and her cytoplasm, and the woman who donated her nDNA and carried the fetus to term.

Mitochondrial replacement therapy has raised many ethical as well as halachic issues. Some have argued that mixing the DNA of three people is creating a new type of life and therefore should not be done. There is also concern that since all the intricacies of the interactions between nDNA and mtDNA are not fully understood, there could be dire consequences to mixing the genes of two women and the health of the child may be seriously affected. Critics worry whether the child could be altered by using the genetic material from two different women and are concerned about social and legal consequences for the child and society. Additionally, others argue that this type of genetic engineering is a slippery slope that can lead to creating children with specific “designer” character traits. Critics argue that there are other options for women who carry mtDNA mutations. These women can use a donor egg in its entirety and have children free of mitochondrial disease (albeit, in this choice, the mother has no genetic connection to the child) or can use prenatal genetic diagnosis to identify those preembryos with few mtDNA mutations [6, 8, 9].

The halachic problems posed by the implantation of an embryo formed through mitochondrial replacement therapy are similar to those raised with surrogate motherhood and egg donation. Egg donation involves two mothers, the genetic mother and the birth mother. The most important halachic question about egg donation concerns the halachic lineage of a child born using an egg donor. This issue is of the utmost concern because Jewish law defines a Jew as someone who was born to a Jewish mother. The question concerning whether the child is Jewish arises when the birth mother is Jewish and the egg donor is not, or vice versa. A related question concerns future marriage. Jewish law, like secular law, forbids incest, including marriage between brothers and sisters. When the father is not the same, the identity of the mother may determine whether a marriage is allowed or forbidden. There is no explicit Talmudic discussion of whether a birth mother or a genetic mother is considered the halachic mother when the two are different people. If the rabbis of the Talmud ever contemplated such a possibility, their discussions and conclusions were not recorded and are lost to posterity. Not surprisingly, there is no current consensus.

It appears that when this question first arose concerning egg donors, the majority rabbinic opinion was that the birth mother, not the egg donor, determined halachic maternity. Among major halachic authorities who held this view were Rabbi Z.N. Goldberg (Techumin, 5:248-259); Rabbi J.D. Bleich (Chalav Treifah and the definition of maternity, Bnetivot Ba’Halacha, 3:47-48); Rabbi Moshe Sternbuch and Rabbi Moses Soloveitchik [11]; and Rabbi Moshe Tendler [12]. These authorities cited various Midrashic and Talmudic sources as precedent or proof by analogy. A discussion of these sources is outside of the scope of this article. However, none of these sources addressed the issue directly, and some of the sources are used as proof by both sides of the issue. (For an excellent and succinct review see Loike and M. Tendler [14]).

The pendulum has apparently shifted and the current majority view appears to be that the genetic egg donor is the halachic mother. Major halachic authorities holding this revised view include Rabbis Avraham Sherman, Meir Brandsdorfer, Mordechai Halperin, and Yosef Shalom Elyashiv [12]. An early authority favoring this view was Israel’s Chief Rabbi Shlomo Goren [13].

There are other opinions as well. Rabbi Shlomo Zalman Auerbach held that there is no definitive answer and that a stringent view must be taken to erase all doubt (Nishmat Avraham 4:186,2004) and Rabbi Eliezer Waldenberg held that a child born through in vitro fertilization has no legal birth mother (Responsa Tzitz Eleizer 45:15). To my knowledge, nobody holds that both the egg donor and the birth mother as dual mothers (as opposed to just a doubt). However, the case of a half-slave half-free person, i.e. a Canaanite slave freed by one half-owner but not the other, is precedent for a mixed halachic status. Recently, Rabbi Moshe Tendler argued that current research showed that both the genetic and birth mother contribute to the development of the child and that therefore, as a stringency, both must be considered mothers. He proposed that in a case of surrogacy, when a Jewish mother’s egg is used, a non-Jewish surrogate should be used and the child should be converted [14].

The view most favorable to mitochondrial replacement therapy is that the birth mother is the halachic mother. Under this opinion, the Jewish gestational mother is the mother and the use of mitochondria from a donor is irrelevant. However, one cannot ignore the authorities who hold the opposing view concerning egg donors. If we accept, by analogy, that use of another’s mtDNA is equivalent to that of the egg donor, then this leads to uncertainty whether the halachic mother is the woman who donates the mtDNA or the woman who supplies the nDNA. A possible halachic solution, following Rabbi Moshe Tendler’s suggestion, would be to use a non-Jewish mtDNA donor and to convert the child, at least a measure of stringency.

There is one other possible solution. There is a broad halachic principle that mixtures follow the attributes of the majority material in the mixture. Concerning matters of whether an item is permitted or allowed under Jewish law, we go after rov, that is, the majority. The mitochondria donor donates only a very small amount of DNA; of the total cellular DNA, 99.9% of the genetic material comes from the nDNA and only 0.01% from the mtDNA. In addition, the majority influence of the makeup of the child is nDNA [15]. Under the principle that in mixtures we go after rov, the identity of the mother should follow the birth mother, even according to those who hold that in surrogacy the egg donor is the halachic mother. This is, of course, only a suggestion. Ultimately, the major halachic decisors of our time will determine the halacha applied to mitochondrial replacement therapy.

Others have argued that the essence of a person comes from the traits created by the 25,000 genes of the nDNA while only energy production comes from the 37 mitochondrial genes, and therefore the procedure should be allowed since it can eliminate horrendous diseases. Since the 37 mtDNA genes are the energy producers, the “batteries” of the cells, they do not determine the characteristics of a person. Therefore 99.99% of genetic material would still come from the mother and the father and only 0.01% from the mtDNA donor. Mitochondrial replacement therapy would only correct potentially debilitating and fatal diseases. In the case of an egg from a donor, the neither the nDNA nor the mtDNA of the birth mother is transmitted to her offspring. Thus, she has no genetic connection to her child. Proponents of mitochondrial disease therapy argue that the procedure is analogous to a recipient of a

kidney transplant or of a blood transfusion. This therapy allows a woman with many mutant mtDNA to have healthy children and terminates the inheritance of her defective mtDNA from transmission to future generations [15]. Another argument is that prenatal genetic diagnosis would not guarantee healthy offspring, whether now or in future generations, because the proportion of mutant mtDNA in one cell of an embryo can be different from the mutations in other cells. The proportion of mutant mtDNA in a cell will also change with development of a fetus, as well as that of an adult [6].

Although mitochondrial replacement therapy has not been tested in humans, it holds potential for alleviating concerns for those who carry mitochondrial mutations of having children with mtDNA-based diseases. To date, there has been no discussion among poskim as to who would be considered the halachic mother if this procedure is performed. However, with the recent decision of the House of Commons and the House of Lords in Great Britain, the ethical questions surrounding mitochondrial replacement therapy have become more pressing. While mitochondrial replacement therapy theoretically has the potential to help many people, its impact on halachic discourse remains to be seen.

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## Contagious Diseases and Vaccination; A Halachic Perspective

Rachel Hersch

Today, vaccinations and immunizations are generally viewed as common practice. While the debate over vaccinations continues in the Western world today, the discussion of contagious diseases and vaccinations has, in fact, been a topic in Jewish law for centuries. Although vaccines are not often thought about from a halachic perspective, Jewish law has much to say on this topic. The discussion of contagious diseases and vaccination is something that dates back thousands of years in Jewish halacha, and the ramifications of this dialogue are still relevant to us today.

The concept of contagious diseases is not new; rather, this concept has been examined in Jewish texts for millennia. Already in the time period of the Rishonim the topic of contagious diseases was discussed. The first example of this is a commentary on Sefer Bereishit when Lot, his wife, and the entire family were leaving Sodom. The passuk in Bereishit (19:17) commands them “al tabet acharacha,” “do not turn around.” The Ramban, who was a noted physician, comments here that the passuk is telling them not to turn around because there may be a “dever” in the air, and the diseases can spread. This is the definition of a contagious disease. Additionally, in Parshat Korach we see another reference to contagious diseases. In the passuk, G-d tells Moshe and Aharon to get away because He is about to destroy Korach and his followers: “hibadlu mitoch ha’edah” (Bamidbar, 16:21). The obvious question is – why would they need to go away? Can’t G-d selectively kill them? Rabbeinu Bchayeh, a famous Biblical commentator who lived in Spain from 1255-1340, answers that when G-d unleashes the contagious disease, it will spread to whoever is nearby. This again is a direct reference to communicable diseases. Rabbi Dr. Edward Reichman, a doctor and professor at Einstein Medical College, explains how this discussion continued as the Black Death, bubonic plague, and other such “plagues” became rampant. One question that emerged at this time was whether or not one was allowed to leave a city in the case of a plague. The Maharil is often quoted as saying, “if there’s a risk, you do not stay in the same place,” and the Rama writes that one should leave at the beginning of a plague [3]. Evidently, from the earliest times in Jewish history, contagious diseases, along with their effect on the community at large, have been discussed.

While it is apparent that the concept of contagious diseases had already existed in Jewish thought for several centuries, the subject of vaccinations and inoculations only came into discussion in the late 18th century. Edward Jenner created the first modern vaccine in 1796 to combat smallpox. He did this by inoculating a person with cowpox, which is a much more benign disease, and thus created immunity to smallpox. This inoculation would work most of the time, however, it had approximately 0.5-2% mortality rate. The question that then follows is whether or not this inoculation is permissible. Dr. Daniel Eisenberg, who works in the department of Radiology at the Albert Einstein Medical Center in Philadelphia

and is an assistant professor at Thomas Jefferson University School of Medicine, explains that although there is a significant statistical advantage of immunization over disease (mortality rate of wild smallpox was about 30%), the general Halachic rule is that one may not be directly responsible for causing the injury or death of another. The parent who allows his or her child to be immunized is doing a definitive physical action that may bring harm to their child. In Jewish law, this is the issue of “shev v’al taaseh” – that it is better to not act than to choose the proactive action. The general rule in Jewish law is that if the outcome of action versus inaction each has a significant downside then we opt for inaction. Additionally, there are Jews who oppose vaccinations “because of the Biblical command of ‘walk simply before the Lord, your G-d,’ which means ‘walk with Him in simplicity and anticipate His support, and do not delve into the future’” [1]. Based on these rationales, it may seem that Jewish law would discourage immunization.

However, these arguments are not compelling enough to make vaccinations assur. The general rule that we choose inaction over action only applies if the risks are equivalent in both of these instances. However, in the case of vaccinations, the risk of contracting the disease far exceeds the risk of vaccination, and therefore, the maaseh is preferable [1]. In addition to this logic, there are also Halachic rulings that deem inoculations as permissible. One such ruling is by Rabbi Abraham Nasich in his book *Aleh Terufah*. In his work, which was published in 1785, Rabbi Nasich articulates a strong opinion to permit smallpox inoculations. Rabbi Nasich lost two children to smallpox [3]. He says that one is required to maintain good health based on the concept of *shmirat haguf*. This is derived from a verse in Devarim, which says, “Only guard yourself and protect your soul” (4:9), and, “And you shall protect your souls exceedingly...” (4:15). Although in context this was referring to one’s spiritual house, the concept is universally accepted in regard to one’s physical well being as well [2]. Rabbi Yigal Shafran, who is the head of the Merhavim Torah Center and directs the Jerusalem Chief Rabbinate’s Department of Medicine and Halacha, elucidates several reasons why immunization is permissible according to Jewish law. One reason is that Jewish law allows one to endanger oneself in order to preserve health. In the case of contagious diseases for which vaccinations are available, the danger of contracting the harmful virus if the entire community is not vaccinated also exists. Additionally, the Sages who lived during the time of the Gemara allowed the use of the health-threatening procedure called bloodletting. This procedure involved the withdrawal of blood from a patient to cure or prevent illness or disease. Rabbi Yitzchak Lampronti (1679-1756) wrote in his work *Pachad Yitzchak* that bloodletting was allowed as a preventative measure despite its danger. From here we see that the potential danger of preventative treatments is ignored if it is preventing a more dangerous situation from arising. The Rambam explicitly states that preventative treatments are in the same Halachic category

as all other remedies. Therefore, vaccination is permissible in order to preserve good health. Finally, Rabbi Moshe Feinstein explains that societal norms determine what is dangerous. Therefore, if the majority of society does not consider something dangerous, it is not dangerous [4]. Based on the ancient and contemporary rulings in these cases, it is apparent that vaccinations are permissible.

Once it is established that vaccinations are permitted according to halacha, the question that arises is whether vaccinations are not only permissible, but mandatory. According to Dr. Eisenberg, there are several reasons why receiving a vaccination would be mandatory. The Rambam derives the obligation to heal from the command to return lost objects. There is a Mishnah that states that not only must one return a neighbor's lost animal, but also must return a neighbor's body. From this, the Rambam derives that one is required to save a person's life. Many contemporary poskim rule that this mitzvah includes an obligation to prevent someone from "losing" their health. Additionally, the Shulchan Aruch describes that there is an obligation to actively prevent illness and danger. This would indicate an obligation to receive a vaccination in order to prevent illness and danger [1]. Moreover, individuals who refuse vaccinations not only put themselves at risk, but may also put others at risk by threatening the transmission of a contagious disease to their family, friends, or community. There is a rabbinic mandate to be proactive in protecting the health and welfare of others, which is learned from the passuk, "If you build a new house, you shall make a fence..." (Devarim 22:8). This commandment extends to avoiding transmission of life threatening plagues and virulent diseases [2].

Further, even if there is no threat of an epidemic, one would be required to be immunized. The Jewish law that requires preventing possible life-threatening risks is not limited to clear and imminent dangers. This is evident in Rabbi Shlomo Zalman Auerbach's halachic ruling in 1992. An infant died within hours of receiving a routine inoculation, and a question was asked to Rabbi Auerbach if an autopsy could be performed on the baby. Rabbi Auerbach maintained that even though the autopsy must be conducted, he stressed that in matters of life and death we must be painstakingly careful. Finally, Rabbi Yosef Shalom Elyashiv holds that routine immunizations are an obligation in order to maintain good health. He says that it is required by parents to assure that their children are immunized, and parents who do not inoculate their children are being negligent. Rabbi Elyashiv explains that since immunization of a child is normal practice throughout the world, one should follow that normative course. The possible danger of precipitating epidemics which may result in devastating complications requires one to be responsible and vaccinate their children. It is clear, according to prominent contemporary poskim, that it is not only permissible to be vaccinated, but it is obligatory [2].

It is apparent that Jewish Law has much to say about contagious diseases and vaccination. Judaism reveres life and therefore it is not surprising that the consensus among poskim is that Jewish law not only permits vaccination, but in fact, obligates vaccination in order to protect one's own health, and the health of the community at large.

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# A Suggested Mechanism to the Hardening of Pharaoh's Heart: A Study in Mind-Controlling Parasites

Yael Horvath

There are numerous occasions in the Torah when God hardens the hearts of individuals and of entire groups of people. Though the most notable example occurs in Exodus 9:12 when God hardens Pharaoh's heart, lesser-known instances have been cited throughout Tanach, as in the cases of King Sihon, and the inhabitants of Canaan when Joshua entered to conquer it (Deuteronomy 2:30, Joshua 11:20). Puzzling and vague, God's recurring allotment of this treatment begs the question of how this could have been accomplished biologically.

While no formal mechanism has been proposed by the traditional commentary of scholars, its prevalence in the literature testifies to its intrigue from early on in history. Most scholars agree that this 'hardening' is psychological, rather than physical, and serves as a way to prevent Pharaoh from repenting [1].

However, this question takes on a new face when considered from the standpoint of modern scientific development. A 'hardened heart,' albeit a figurative reference to the hardening of spirit rather than of the literal heart, may in fact be the product of a chemical change in the body producing a change in mindset. The psychology of an individual has long been known to rest on the synchrony of chemicals and hormones. Therefore, as physical units that comprise our biological makeup, it is possible that they were the agents modulating the mechanism behind the hardening of Pharaoh's heart, introduced into his body by the invasion of a manipulative parasite. Such parasites, found in extreme abundance on earth, have been largely studied for their ability to addle their victim's brains and induce behavior that is self-destructive or contrary to his or her own natural instinct. One parasite, for example, reproduces by hijacking a cricket's mind and ultimately causing the cricket to commit suicide by jumping into the nearest body of water. Once the cricket succumbs to its own death by drowning, the parasite wiggles out of the cricket's body and into its ideal aqueous reproductive environment [2, 3].

Another such parasite, the single-celled *Toxoplasma gondii*, or toxo, for short, infects a wide variety of mammals, but can only sexually reproduce inside a cat. Scientist Joanne Webster has found that when toxo gets into a rat or a mouse, it chemically alters its brain to deliberately seek out the smell of cat urine, rather than to run away from it. Thus the cat preys on the mouse and toxo, now in its final destination, reproduces into zygotes [4].

The toxo parasite is particularly eerie because, like cats, humans are mammals, and are made up of the same basic structure, cell

types, and chemicals. It is not wholly illogical therefore, to argue that toxo may exist in human populations as well; in fact, extensive research has shown that this is precisely the case [4]. Current research is being conducted on the topic of this particular parasite because toxo's prevalence in our environment presents a high risk of infecting humans as well as cats. In fact, cats shed toxo's zygotic oocysts into the environment through their feces, where the parasite can be easily transmitted to humans who have frequent contact with cats. Toxo can also be picked up from grazing animals such as pigs and cattle. Interestingly, when the oocyst enters the body of non-cat organisms such as humans, toxo zygotes develop into their mobile, rapidly dividing stage of life and are carried via the blood stream to various organs. A natural immune response mediates the clustering of parasitic offspring into the brain and muscles [5]. Thus, its exposure to the brain and its capability of disrupting the chemical balance of our minds may possibly lend support to how Pharaoh's psychology was changed.

According to the Center for Disease Control, more than 60 million people in the United States today may be infected with the toxo parasite. Though it is not connected to any overt and deadly illness, it can manifest itself in those with compromised immune systems, such as pregnant women. Further research has shown that it can cause changes in personality and some researchers say that those with schizophrenia are more likely to be infected with toxo [6]. In addition, infected men and women are more likely to be involved in traffic accidents and engage in self-violence [7].

Furthermore, a study has shown that the suicidal crickets mentioned above comprised 60% of the diet of local trout in a stream studied by Japanese scientist Takuya Sato, proving that parasitic control is frighteningly common [9]. The notion that manipulation was a rare oddity was thus overturned, strengthening the possibility that local and ubiquitous parasitic populations could have gained easy access to Pharaoh's body, manipulating his mind into obstinacy.

Therefore, it is worth considering whether those whose hearts were 'hardened' fell victim to a psychology-altering parasite that shifted the chemical makeup of their bodies and minds. If God works through natural pathways to accomplish His agenda, it is possible to combine religious and scientific perspectives to explain the mechanism behind this phenomenon cited in Tanach. Therefore, research being conducted on this subject may not only have implications for the future, but may also shed a modern light on our past.

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# Black Jews of Africa: Beliefs, Customs, and Genetics

Ariella Levie

How do we define ourselves as Jewish? By our practices and customs? By our family history? By our beliefs? The implementation of genetic coding has made it possible to use our genetics as a means to better identify who we are. Recently, this area of science has been broadened to help discover people's religious affiliations. This method of identification has been somewhat controversial, as it may lend itself to the exclusion of people from religion based solely on their genetics, not on their beliefs. However, this method has become increasingly important in determining the origins of many unknown African sects. In the past fifty years there has been a surge of newly discovered African tribes and clans who claim to descend from Jewish origins. With the aid of the human genome project and the cooperation of thousands of Jews and non-Jews around the world, significant headway has been made in confirming the Jewish origin of many African tribes.

For centuries, the world's Jewish community has had very little knowledge regarding African Jewry. In relatively recent history there has been a surge of interest among world Jewry regarding the Jews of Ethiopia. There are three main schools of thought regarding the origins of these presumably Jewish people. The first opinion suggests that these people descended from Jews who were exiled after the destruction of the second temple. This opinion is not widely accepted because the tradition of the Ethiopian Jews states that there was only one temple. Additionally, when these Jews were asked about holidays that originated after the first temple, like Purim and Chanukah, they were unfamiliar with these holidays. This helps prove that the split between the Ethiopian Jews and the remaining Jews preceded the events of the destruction of the second temple. A second accepted opinion states that Ethiopian Jews are the descendants of Menelik I, the son that the Queen of Sheba conceived with Solomon, the king of Israel. The *Kebra Nagast*, a compilation of the oral history of the Ethiopian people, contains an account of the initial meeting between the Queen of Sheba and King Solomon. Following the meeting, the work recounts the Queen of Sheba's return to Ethiopia where she proclaims to the people, "From this moment I will not worship the sun, but will worship the Creator of the sun, the God of Israel." Her son fathered by King Solomon was originally named David II, but when he grew to adulthood he changed his name to Menelik I. When he reached twenty years of age, he traveled to Israel to visit his father. When they met, Solomon tried to convince him to succeed him as the king of Israel. Menelik I refused, but promised to bring the ways of Israel back to Ethiopia. According to the *Kebra Nagast*, Solomon sent Menelik I back to Ethiopia with the cloth that covered the Ark. Upon his return to Sheba, he converted many of his followers to Judaism [1]. Although this text is not consistent with the accounts of the Tanakh, there may be some truth behind the Ethiopian legend, as the Tanakh described a meeting between Solomon and the Queen of Sheba (I Kings 10). The third and most widely accepted opinion is that these Jews originated from the lost tribe of Dan, which was exiled by the

Assyrians in the year 722 BCE (II Kings 17:3-6). This opinion stems from the oral tradition of the African Jews.

In the year 1964, when many Ethiopian Jews began making the journey to Israel, there was no way to genetically determine if these people were truly of Jewish origin. The only means of identifying their Jewish heritage was through the similarity of their ritual practices and beliefs with those of the Jewish tradition. Like the Jews outside of Africa, the Ethiopian Jews are monotheistic and believe in many of the concepts written in the Torah. The scriptural basis of their religion comes from the Orit (from the Aramaic word *Oraita*, meaning Torah). The scripture contains the Five Books of Moses and the books of Joshua, Judges and Ruth. Their Orit also contains books of unclear origin like *Mota Muse* (Death of Moses), *Mota Aaron* (Death of Aaron), and *Abba Elias* (The Father of Elijah). Most African Jews keep the strict dietary laws of the Jews that are set out in the Five Books of Moses. They refrain from eating milk and meat together, and they do not eat any pig products. They are also forbidden to eat food slaughtered by someone outside their tribe, a stringency they took upon themselves to ensure the highest quality of Kashrut. The holidays of the Ethiopian Jews also highly resemble traditional Jewish holidays. They celebrate Pesach, Shavuot, Yom Kippur and Sukkot. They also have additional holidays, like a day of celebration for the day that Moses was allowed to see the back of God. Additionally, a majority of the religious Ethiopian Jews fast on Thursday in preparation for the holy Sanbat (Sabbath) [2].

Although the overt similarities between the Jews of Israel and the Jews of Africa led many to accept these African people as Jews, many were still unsure about the true status of the Ethiopian Jews. When technology began to allow for the coding of individual DNA, people began to wonder whether it would be possible to identify specific DNA sequences, which would confirm the genetic linkage between the Jews of Israel and Africa. Due to the immense isolation of the Jewish people and their emphasis on marrying only within the Jewish community, the discovery of a "Jewish DNA" was highly plausible.

There are two non-recombinant portions of our DNA, which would technically remain the same generation after generation, excluding any major mutations. Such DNA includes mitochondrial DNA (mtDNA), which is transmitted exclusively from mother to child, and the non-recombinant region of the Y chromosome (NRY), which is transmitted exclusively from father to son. If it is true that the Jews had limited intermarriage, then many Jews today would share significant amounts of their non-recombinant DNA, despite the large geographic distances between them. After a plethora of genetic screening, it was found that Sephardic Jews shared more DNA with Ashkenazi Jews than with the people of the surrounding Middle Eastern non-Jewish communities, like the Palestinians, Syrians and Druze.

In genetic screening among Ashkenazi Jews, a large drift toward the European gene pool is apparent. This shift is most likely due to admixture with the local European non-Jewish communities [3]. Polymorphisms, which are natural variations in DNA sequences, are most often used to trace Jewish ancestry. A group of people with similar polymorphisms is most likely connected in some way. The more similar these polymorphisms are, the closer the relationship of the people in the group. Studies of polymorphisms of the NRY in both the Ashkenazi and Sephardic communities showed that variation of the haplotype, which is a group of polymorphisms that tend to be inherited together, was strongly linked to the host nations and the communities in which they lived. Much stronger evidence of “Jewish DNA” was found on mtDNA. Researchers found 8 modal haplotypes at the HVS-1 region of the mtDNA in 10 geographically separated Jewish communities. Of these 10 regions of the mtDNA, two haplogroups, the K and N, were found in 40% of the current population of people who claimed to be Jewish. Unfortunately, it was discovered that the mtDNA haplotypes which were shared among the 40% of Jews were overrepresented in the non-Jewish community as well, thus making the high percentage of Jews with the gene statistically insignificant. The analysis of various records confirmed that no genetic motif that was thought to be significant was exclusively Jewish. Because of the inconclusive evidence, it has become virtually impossible to genetically determine if the Jews of Ethiopia truly descended from the same lineage as all other Jews [4].

As the number of black Jews discovered in Africa began to grow, the Israeli rabbinate and government began to discuss the halachic status of these peoples. Would African Jews be given the “right of return” to Israel? Israel’s Law of Return was passed on July 5, 1950, and it gave all Jews the right to return to and live in Israel, as well as the right to gain citizenship. In 1970, the right of entry and settlement was extended to people of Jewish ancestry, yet the question remained whether the Ethiopian Jews would be included in the legislation. Additionally, if these people immigrated to Israel, would they be able to marry mainstream Jews, or would they need prior conversion? In 1973, Rav Ovadiah Yosef, the Sephardic Chief Rabbi of Israel, along with Rabbi Shlomo Goren, the Ashkenazi Chief Rabbi of Israel, declared that the Ethiopian Jews were to be accepted as fellow Jews and given the right of return to Israel. In their declaration they stated, “You are our brothers, you are our blood and our flesh, you are true Jews.” The opinion of these rabbis followed the early psak of the Radbaz in the 16th century (Responsa Radbaz 4:219). However, the Israeli rabbinate required that these people undergo a modified conversion process, which consisted of immersion in the ritual bath and a symbolic “re-circumcision” for the men. At the time, many poskim were opposed to this ruling, most notably Rabbi Shlomo Zalman Auerbach and Rav Moshe Feinstein (Tzitz Eliezer 104-105).

Another group of Africans called the Lemba tribe presumably descended from Jews. As the search continued for “Jewish DNA,” it became increasingly difficult for researchers to pinpoint genes with definitively Jewish ancestry. The data collected might have been inconclusive for identifying “Jewish DNA” because it was possible that many of the people who identified as Jews were not truly of Jewish descent, as they may have been adopted or converted. Rather than search for DNA sequences that represented all Jews, a decision was made to focus on the DNA of the cohanim, the Jewish priests. This DNA would be easier to pinpoint because

of the discrete laws relating only to a cohen. According to Jewish law, a Jewish priest must marry a woman who was born Jewish and is not allowed to marry a convert, both of which guarantee the purity of his heritage (Leviticus 21: 7,14). Many priests even took upon themselves the stringency not to marry the daughter of two converts, even though she was legally born a Jew and it was permissible to marry her (Shulchan Aruch, Even HaEzer 17:1). This manner of precision in regard to preserving the purity of the priestly line allowed for the increased possibility of discovering cohen-specific DNA. Additionally, since the priesthood is a patrilineal dynasty that was founded by one man, Aaron, it is easier to search for a Y-chromosome haplotype. In order to prove that the specific DNA is from the cohen line, it is imperative for the DNA sequences to be found in both Ashkenazi and Sephardic men, thereby showing that the origin of the DNA preceded the dispersion of the Jews. Since the priesthood is passed only from father to son, analysis of the NRY produced results that led to the discovery of the Cohen Modal Haplotype (CMH), the “cohen gene.” Original studies on the CMH showed that there was a 6 locus Y-STR (single tandem repeat) haplotype that belonged to the Jewish priests. The origin of diversity associated with the CMH could be dated between 4280 and 2100 years ago, roughly around the time when Aaron lived. The key argument for the legitimacy of the CMH is rooted in its predominance both in Ashkenazi and Sephardic cohanim and its remarkable absence in non-Jewish populations [5]. In recent years, research was done to extend the CMH to include more STR Y-chromosome markers to gain higher resolution and more specific genetic signatures. New findings have indicated that about half of contemporary Jewish cohanim share the Y-chromosomal segment J-P58. The study was done on a sample of 215 cohanim from diverse Jewish communities, 1575 Jewish men from all over the world, and 2099 non-Jewish men from the Near East, Europe, Asia, and India. Their genes were analyzed using several techniques including allele specific PCR, TaqMan, Kaspar, and direct sequencing. 21 Y-chromosome haplogroups were noted, yet 9 of those haplogroups were found in high percentages in other groups as well. As a result, 12 Y-STRs were isolated as purely cohen DNA. In most cohanim from diverse backgrounds, it was found that 5 haplogroups accounted for 79.5% of the Y-chromosome. The most important finding was the finding of the J-P58 gene, which is present in 51.6% of Ashkenazi and 39.7% of non-Ashkenazi cohanim. The rest of the haplotypes found were all found at frequencies below 20%. The study concluded that 46.1% carried the J-P58 gene, which supported the single patrilineal origin of the Jewish priests [6].

A stunning discovery in 1995 gave scientists the ability to utilize the newly found CMH to identify the potential lineage of a tribe of Africans living in South East Africa. The tribe, known as the Lemba, had very similar traditions and practices to the other African Jews. In Bantu languages, “Lemba” means “accepted foreigner,” indicating that the roots of these people were from a place outside of Africa. These particular African Jews stand out because they claim that they descended from the priestly line of Aaron the cohen. The people of the Lemba tribe amount to about 50,000 people and are found mostly in Zimbabwe and South Africa. The Lemba tribe observes the Sabbath, refrains from eating many forbidden foods including pig, believes in male circumcision, and forbids marriage outside the Lemba people. These practices closely resemble Jewish tradition and are a far cry from other African practices. The Lemba tribe also places the Star of David on their

tombstones and offers a yearly sacrifice called the Pesah, similar to the ritual Pesach offering of the Jews. Tudor Parfitt, a scholar on the subject, has commented on the amazing phenomenon that there is a group of people in Africa who practices so many Middle Eastern Semitic practices, despite their geographic distance from Israel. The Lemba believe that they are the descendants of Jews who came from Judea, together with the forerunners of the Ethiopian Jews, and that they left to travel further down the coast of Africa. They believe that they stem from a group of white Jewish priests who emigrated from Israel without any women and therefore eventually married local black females [7]. Normative orthodox Jewish laws today state that matrilineal descent determines Judaism, so unless the African women were converted, it is highly unlikely that any of the Lemba people are considered halachic Jews. Although these “Jews” may not be halachically Jewish, it is still intriguing to compare their Y-chromosomes to the CMH, especially because they claim to have descended from the line of Aaron. Buccal samples were collected from unrelated Lemba, local Bantu, Yemenite, Ashkenazi, and Sephardic men. In general, the Lemba population had many genetic markers that were consistent with markers in people originating from the Middle East. These DNA markers are most often found in Jews and Arabs and, considering the geographic distance, were found at remarkably high rates in the Lemba people’s chromosomes. The studies of the Buba clan, a subgroup of the Lemba, were specifically intriguing because the

Buba clan has traditionally been thought of as the priestly group of the tribe. Genetic studies found that 50% of the Buba men had the CMH gene, which is statistically significant when compared to percent of the general Jewish public that has the CMH gene. Of the Lemba men studied, 13 were from the Buba clan and 7 of them had the CMH gene. While the study cannot define the Lemba as Jews, the genetic results confirm the oral accounts of ancestral males originating from the Jewish priests, the Buba clan in particular. Analysis of the mtDNA showed no evidence of Semitic origin, which is consistent with their tradition that all the females of the clan came from local African communities [8].

While the Ethiopian Jews had a relatively speedy transition into Israeli society, the case of the Lemba has been very different. As Gideon Shimona, a scholar of South African Jewry, stated, “In terms of halakha, the Lemba are not at all comparable with the Falasha. As a group, they have no conceivable status in Judaism” [9]. Even though these people are not truly Jewish, the genetic screenings have proven their origin from the Jewish priestly line of Aaron. Although there are many ongoing debates as to whether genetics can pose as a legitimate basis for halachic rulings, many of the Lemba who have opted to move to Israel have undergone a full halachic conversion, unlike the modified and shortened version of the Ethiopian Jews.

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# Whose Blood is Redder? A Halakhic Analysis of Issues Related to Separation of Conjoined Twins

Elana Perlow

What could be more important than the immeasurable value of a single life? Can prolonging one life at the expense of another be justifiable? Unfortunately, for some cases of conjoined twins, these questions demand life and death decisions as precious time runs out and the babies' lives rest in the balance. Although conjoined sets of twins are rare, the complex issues involved in such cases cause many concerns within Jewish law in addition to weighty medical and ethical dilemmas.

There are two types of twins: fraternal and identical. Fraternal twins, also known as dizygotic twins, result from the fertilization of two eggs by two sperm. Identical, or monozygotic, twins are formed from the fission of a zygote resulting in two genetically identical individuals. Conjoined twins are a type of monozygotic twins whose origins are scientifically debated. One commonly accepted theory proposes that conjoined twins arise from the incomplete fission of the zygote, resulting in two individuals who are physically attached to each other. According to a second hypothesis, after the zygote undergoes fission, the stem cells from one embryo seek out similar cells in the second embryo and re-fuse [1].

Conjoined twins may be attached at the head, chest, back, or pelvis. In many cases, these twins can be successfully separated by surgery and go on to lead normal lives. In the case of thoracopagus conjoined twins, who are joined at the heart and liver, separation is necessary but has dire consequences. In other cases, surgery is not a viable option because the twins share vital organs.

In 1977, in Lakewood, New Jersey, a set of thoracopagus conjoined twins was born to a prestigious rabbinic family. The sisters were joined in the frontal area from the shoulder to the pelvic region. They shared one six-chambered heart, composed of a stunted two-chambered heart fused to a normal four-chambered heart. The wall separating the four-chambered heart from the two-chambered heart was too thin to divide between the twins. Even if this wall had been thick enough to allow for surgical separation, the two-chambered heart would not have been able to support the infant's life. The twins' surgeon, Dr. Everett Koop, informed the family that if they were not separated, both twins would die. However, if the twins were separated, only the stronger twin would live at the expense of the weaker twin [2,3]. From a medical standpoint it was clear that the babies needed to be separated. However, according to Jewish law, many questions were raised. Taking a life is no simple matter. Accordingly, there must be a valid halakhic reason to separate the twins, thus ending one child's life. Without a valid reason, performing the surgery would have been forbidden because it is considered equivalent to killing one of the twins, despite the fact that both babies would die if not separated from one another.

A fundamental idea in halakha is that one life may not be saved at the expense of another. While analyzing the three cardinal sins of

idol worship, immoral relations, and murder, the Talmud in both Yoma 82b and Sanhedrin 74a examines a case in which a man approaches Rabbah for advice. The man's life was threatened if he would not kill a specific person. Rabbah tells him that he must sacrifice his life and not kill, for he does not know "whose blood is redder." From this it can be derived that a person cannot take an innocent life, even at the expense of one's own life, for it is not man's role to determine who will live and who will die.

However, the Torah states two exceptions to the above rule that are analogous to the case of separating conjoined twins. The first exception is the case of a *rodef*, a pursuer. The Torah says, "Do not stand idly by the blood of your neighbor" (Leviticus 19:16). From this, the Mishna (Sanhedrin 8:7) elaborates that if one person is pursuing another, the *rodef* should be killed in order to protect the pursued. These laws also apply in a case of unintentional pursuit by the *rodef*, as illustrated in Ohalot 7:6. This Mishna discusses a situation in which a mother's life is threatened while in childbirth. If the baby is still in utero, the mother's life takes precedence over the infant's. The Mishna explains that the fetus is considered an unintentional *rodef* and should therefore be sacrificed to save the mother. However, the Mishna continues to say that, if the baby's head has emerged, the newborn cannot be sacrificed to save the mother because the baby is now an independent being.

The Talmud (Sanhedrin 72b) asks why the Mishna permits one to save the mother when the fetus is still in the womb but forbids involvement once the baby's head has emerged. It would seem that the infant should be considered a *rodef* regardless of its position. However, the Talmud explains that once the head has emerged, Heaven, not the infant, is the *rodef*. As Maimonides, a medieval Sephardic philosopher, elaborates, childbirth is "*tivo shel olam*," the natural course of the world. In both cases, the child not only endangers the mother's life, but the mother also endangers the child's life, and they could be classified as mutual pursuers [3].

In his commentary on Ketubot 33b, Rabbi Akiva Eger explains that in a case of mutual pursuit between two individuals, a third party should not become involved because the two lives are equally valued. If this is the prevailing halakha, one would think that a fetus whose head has not yet emerged cannot be sacrificed to save its mother since each poses a threat to the other. Yet Rabbi Moshe Feinstein explains that in a case of mutual pursuit, if one of the individuals poses a qualitatively greater threat than the other, then that individual is deemed the *rodef* and may be sacrificed to save the life of the other [3].

Additionally, the Torah teaches that feticide, unlike homicide, is not a capital crime. It states in Exodus 21:22, "And if men strive together, and hurt a woman with a child, so that her fruit depart, and yet no harm follow, he shall surely be fined, according as the

woman's husband shall lay upon him; and he shall pay as the judges determine". The Rabbis deduce from this verse that feticide is not a capital offense and demands only monetary compensation (Chagiga 11a). In contrast, unpremeditated manslaughter cannot be resolved by payment of a fine; one who commits such an offense must seek asylum in a city of refuge. Prior to the emergence of its head, the unborn child is considered a fetus, and any lethal threat it poses to its mother is considered homicide, which is a capital offense, and any threat the mother poses to her unborn child is considered feticide. Once the infant's head has appeared, it gains the status of an independent human being, and killing it is considered homicide.

Another exception to the fundamental idea that one life may not be saved at the expense of another life is derived from Samuel II (20:1-23). Sheva ben Bikhri led a rebellion against King David. Yoav, David's army general, chased after Sheva and besieged the town in which Sheva was hiding. Yoav declared that if the townspeople handed Sheva over, the siege would end, and innocent civilians would not be harmed. Upon hearing Yoav's proposal, a townswoman threw Sheva ben Bikhri's head to Yoav, thus sacrificing him to save the townspeople.

Based on this account, the Talmud Yerushalmi analyzes a parallel case in which a caravan of Jews is surrounded by heathens (Terumot 8:4). The heathens demand that unless the Jews in the caravan give over one of the Jews, the entire caravan will be killed. The Jews are prohibited from acquiescing to this request, even if it will result in all of their deaths. In contrast, if the heathens had demanded that a specific individual be given over, the Jews would be allowed to obey the request in order to save their lives. Rabbi Shimon ben Lakish clarifies that in order for the Jews to hand over the designated individual, it must be known that the specified person is guilty of a capital offense. Rabbi Shimon ben Lakish derives this conclusion based on the case of Sheva. Sheva ben Bikhri was deserving of the death penalty for rebelling against King David, since rebellion against the king is a capital offense. Therefore, it was permitted for Sheva to be sacrificed for the safety of the town. Rabbi Yohanan disagrees with Rabbi Shimon ben Lakish and states that the specified person should be handed over, even if he was not deserving of the death penalty, because the enemies specifically demanded that he be handed over. Rashi expounds on Rabbi Yohanan's opinion and states that if protecting Sheva ben Bikhri would not have prolonged Sheva's life and still would have resulted in the murder of the townspeople, it would have been permissible to deliver him to Yoav. But, if it were within their capacity to save Sheva ben Bikhri, then the townspeople would have been forbidden from sending him to his death. Maimonides cites only Rabbi Shimon ben Lakish's opinion (Hilkhos Yesodei HaTorah 5:5), but the Ran agrees with Rabbi Yohanan (Yoma 82b). Rabbi Moshe Feinstein explains that in this case, the designated individual will be killed whether the others deliver him into the hands of the heathens or try to protect him [3].

Yet how could Rabbi Yohanan rule that it is permitted to shorten an individual's life simply because he is the designated victim? Through an analysis of Rabbi Moshe Feinstein's earlier writings, Rabbi J. David Bleich explains that the caravan surrounded by heathens is similar to the case of two pursuers, in which the specified

individual and those who have been requested to hand him over represent mutual pursuers. Although it is an unintentional pursuit, the designated victim's mere existence poses a greater threat to the overall community because he is destined to die relatively soon, while the other individuals anticipate normal longevity [3].

Rabbi Shimon ben Lakish argues by stating that the only pursuers are the heathens. The designated individual may only be delivered to the heathens if he is deserving of capital punishment. If he is not deserving of capital punishment, he is not considered a rodef, and is seen as a victim. Rabbi Moshe Feinstein elaborates that this individual gains the status of a rodef, even if he has not committed a capital crime, but has committed any act that may have offended the heathens, thereby placing the caravan in danger [3].

The situation in which a baby whose head has emerged from the womb and is threatening his mother's life is considered a case of mutual pursuit and is consistent with Rabbi Shimon ben Lakish's opinion. According to Rabbi Yohanan's interpretation, the mere existence of the designated victim in the caravan poses a threat to the others and classifies him as a rodef. The baby poses an even greater threat than the designated individual in the caravan, because the baby actively threatens the mother's life as it pushes through the birth canal.

These halakhic discussions can also be applied in the case of the thoracopagus conjoined twins in Lakewood, New Jersey. According to the twins' surgeon, Dr. Koop, it was known that if the sisters were not separated, both would die within nine months, and if separated, the weaker twin would surely die. The case was brought before Rabbi Moshe Feinstein to determine if it was permitted to perform the surgery at the expense of the weaker twin's life. He inquired if the heart belonged specifically to one sister or if it could be shared by both. Dr. Koop responded that it was clearly the stronger twin's heart and the weaker twin's life could not be extended, even if she were to receive the heart. Therefore, Rabbi Moshe Feinstein concluded that the weaker twin was considered to be a treifah, an individual who has less than a year to live.

Through an analysis of Rabbi Moshe Feinstein's earlier responsa on the Talmud Yerushalmi, Rabbi Bleich suggests that Rabbi Feinstein thought that the situation represented one in which the conjoined twins posed a mutual threat to one another. Mutual pursuit indicates that surgery should not be performed because a third party should not become involved in a case of mutual threat [3].

Although it is forbidden to take the life of a pursuer in a case of mutual pursuit, it may be permitted to separate the twin sisters based on Rabbi Shimon ben Lakish's opinion. While killing a treifah is still considered murder, it is not a capital crime. Medical evidence indicates that in cases of thoracopagus twins, the twin on the left side of the connection has a greater chance for survival than the twin on the right. Additionally, in the Lakewood case, the weaker, right-sided twin had cardiovascular anomalies and was incapable of living for longer than a few short months, regardless of whether the surgery were to be performed [3]. In this specific case, the weaker twin's congenital anomalies deemed her a treifah. According to Rabbi Shimon ben Lakish, although the two were mutual aggressors, the threat posed by the treifah twin as an unintentional

rodef to her sister was greater because it was considered homicide—a greater offense than killing a treifah. Therefore, Rabbi Feinstein concluded that the weaker sister's life could be sacrificed in order to save the life of the stronger sister.

After discussing this case with his father-in-law Rabbi Moshe Feinstein, Rabbi Moshe Tendler concludes that even according to the Rabbi Shimon ben Lakish, the twins can be separated, for even though “there was no ruling of a beit din [Jewish court] that she was guilty of any sin and therefore would be subjected to capital punishment, Hashem [G-d] Himself issued such a ruling. There was an edict from Heaven that the child could not live” [2]. The twin deemed a treifah was designated by Heaven to have a shorter amount of time on this Earth.

According to Rabbi Yohanan, the conjoined twins could be separated because the weaker twin had been “designated” for death by her inherent biological state. In the case of Sheva ben Bikhri, Rashi explains that he should have been delivered to the

surrounding army if his death were a certainty in order to prevent the destruction of the entire city. Similarly, because the treifah sister has a limited lifespan, the surgery should be performed to prevent the death of both sisters. By extrapolation, Maimonides and Rabbi Shimon ben Lakish would likely draw the same conclusion, albeit through different reasoning. The twins cannot be separated even though the weaker twin was “designated” because she is not guilty of a capital crime but rather because of her status as a rodef who poses a greater qualitative threat.

On October 11, 1977, Dr. Koop performed the first successful surgery of separation of thoracopagus twins on these sisters. Unfortunately, although the surgery was a success, the surviving child contracted hepatitis B from a blood transfusion and died forty-seven days after the surgical procedure [3]. The surgery was a revolutionary moment not only in the medical world, but because it also allowed for the development and application of halakha in a new realm of science pertaining to life.

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## BRCA1:185delAG. Just an 'Ashkenazi Mutation'?

Chana Ratner

**B**reast cancer is the most common cancer in adult human females and one in every ten women will develop breast cancer in her lifetime. There are different factors that can increase a person's risk for developing cancer (i.e. environmental factors, hormones, obesity), but the main factor is family history [1]. Between 5-10% of breast cancer cases are due to a hereditary component.

In 1990, researchers discovered the first gene associated with breast cancer. This gene is known as BRCA1, and it is located on chromosome 17 [2]. In 1994, further studies linked another gene, designated BRCA2, to familial breast cancer. This research demonstrated that genes other than BRCA1 could be linked to breast cancer.

When functioning properly, both BRCA1 and BRCA2 are tumor suppressor genes. These genes regulate cell growth and cell death. Mutations of this gene can lead to both abnormal cell growth and uncontrolled cell death. Every person has two BRCA1 genes (one on each chromosome 17) and two BRCA2 genes (one on each chromosome 13). When there is a mutational change in one copy of either the BRCA1 or BRCA2 gene, a person's risk for developing various types of cancer rises dramatically, although both copies of the gene must be mutated before a person develops cancer [2]. Mutations in the BRCA1 or BRCA2 genes increase the risk for developing breast and ovarian cancer 10-20 fold [1]. Alterations or mutations in the BRCA1 or BRCA2 gene are only some factors in cancer development; several mutations in different growth regulator genes can also cause cancer formation.

Mutations that become prevalent in a specific ethnic group are usually attributed to the founder effect [3]. The founder effect is caused by a limited group of ancestry being isolated from an original population. If this separation continues, disease producing alleles present in the founders will become more frequent in the following generations. The 185delAG mutation within the BRCA1 gene was identified in about 1% of the Ashkenazi population, causing the Ashkenazi Jewish population to be considered a high risk group for breast and ovarian cancer [4]. This mutation, found in a high percentage in Ashkenazi Jews, has been coined the 'Ashkenazi mutation' [5]. A study conducted in Israel found that all tested Ashkenazi mutation carriers displayed the same allelic (alternative form of a gene) pattern, suggesting a common ancestor and the involvement of a founder effect [5].

Even though this mutation is associated with Ashkenazi Jews, it is not as specific to Ashkenazi Jews as was once thought. There has been evidence that this mutation is also present in Sephardi Jews. Researchers in Israel conducted a study regarding the 185delAG BRCA1 mutation that expanded the study group to other Jewish non-Ashkenazi groups: Moroccan, Yemenite, and Iranian [5]. The researchers found the 185delAG mutation in the non-Ashkenazi groups that they examined. Therefore, the researchers concluded

that this mutation was not unique to Ashkenazim, but is present in other Jewish groups, both in individuals with breast and/or ovarian cancers as well as in the general population. They also found that 37.5% of the individuals studied shared the common Ashkenazi genetic markers while 25% of them had a pattern that was only slightly different with these same markers. These findings support the belief of a common ancient founder for this mutation in the Jewish population of different ethnic origins. Traditional historic accounts relate that the Jewish population was exiled several times throughout history, with the last exile occurring in 70 A.D. After the destruction of the Second Temple, the Jewish people were dispersed, leading to the Jews settling in Eastern Europe (Ashkenazi Jews), Iraq (Mizrachi Jews), and North Africa (Sephardic Jews). These Jewish populations remained geographically and culturally separate from each other [5]. The discovery of the 185delAG mutation in Ashkenazi, Mizrachi, and Sephardic Jews is evidence for a common ancestor, and also leads scientists to suspect that this mutation had arisen before the destruction of the Second Temple and the separation of Jewish communities.

Another study found a repeated occurrence of this mutation in Iraqi cancer-prone families. This further illustrated that this mutation was not unique to Ashkenazi Jews. Through genetic analyses of several genetic markers, the researchers identified common origins for Ashkenazi, Iraqi, Iranian, and Libyan Jews. They also concluded that this mutation may be part of the "ancient Jewish genetic pool" dating back to the Second Temple era [4].

This mutation was also identified in groups of questionable Jewish ancestry. A study of self-identified Latinos with breast and ovarian cancer from San Luis Valley, Colorado led researchers to find a repeated occurrence of the 185delAG mutation. Out of the seventeen Spanish families with the 185delAG mutation, three of them were Spanish-Gypsy, one was of Jewish ancestry, and one was of Sephardic Jewish heritage. Haplotype analysis on thirteen of these families showed that all but one had the common Ashkenazi Jewish haplotype. The study concluded that the 185delAG mutation was common in families with breast and ovarian cancer who originate from the San Luis Valley [6]. After this study was published, Harry J. Long, a medical oncologist at the Mayo Clinic, said that there is "a high probability that these people are descendants from Marranos or Spanish Jews who pretended to convert to Christianity during the inquisition" [7].

In 1492, King Ferdinand and Queen Isabella of Spain forced all Jews in the country to convert or leave, causing the emigration of over 100,000 Jews [7]. Some Jews fleeing Spain travelled to present-day California and New Mexico, which would indicate that the Latino group with the 185delAG mutation could possibly be descended from Spanish (i.e. Sephardic) Jews from that era. This would further strengthen the belief that 185delAG mutation exists among Sephardic, in addition to Ashkenazi, Jews.

Another study was performed in Ecuador and again in Colorado where a dominant presence of 185delAG mutation was found. While performing Y chromosome mapping and other genetic analyses, genetic signatures of Sephardic ancestry were identified in these communities. This suggested that the mutation in these two communities may have a Jewish origin. This finding showed that the Hispanic population and Latin American population may have a “certain degree of cryptic Jewish ancestry” [8].

Breast cancer is the most commonly diagnosed cancer in Hispanic women, so it is unsurprising that the 185delAG mutation has also been identified in the Hispanic population [9, 10]. “With the exception of Ashkenazi Jewish subjects, Hispanics had the highest rate of BRCA1 mutation (10.8%) among women younger than 65 with breast cancer and with a family history of cancer” [10]. Researchers also found this mutation in a non-Jewish Chilean family. They identified in this family a haplotype that was identical to that of the Ashkenazi Jewish population. This family was of

Spanish descent and had been living in South America for at least four generations. The researchers noted that “it is possible that the crypto Jews of Sephardic origin carried this mutation to the new world” [11]. They speculated that the identification of the 185delAG mutation in this non-Jewish Chilean family suggests that other Chileans carry this mutation as well and are descendants of Jews.

The presence of the 185delAG mutation in Sephardic Jews as well as non-Jews points to the fact that this mutation is not solely an Ashkenazi mutation. This mutation likely arose during the Second Temple period, before the exile of the Jewish people. Since some Sephardic Jews carry this mutation, we can speculate that these genetic mutations were carried by Marranos who came to the Americas and transmitted this mutation to their offspring, resulting in the presence of these mutations in present-day Hispanic and Latin-American populations.

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# Ancient Maladies: An Exploration of Disease and Pathophysiology in Tanach and the Talmud

Jeni Rossberg

The canonical ancient Jewish sources, specifically Tanach and the Talmud, are the guidebooks for how Jews live their lives. They contain ageless morals and lessons, prescribe rules and customs for a holy life, and provide a window into the history and development of the Jewish people. Neither Tanach nor the Talmud is primarily viewed as a reference for modern or medieval medical procedures. Nevertheless, there are many examples in Tanach and discussions in the Talmud that focus on cases of pathophysiology, which are abnormal physiological changes associated with a disease. Surgical or alternative disease treatments are also considered. Various descriptions in Tanach, discussions among the rabbis in the Talmud, and findings of medical historians provide a glimpse at ancient medical afflictions, diagnoses, and treatments. It is important to remember that the medical cases found in the Talmud were not intended to act as a medical or scientific record; rather, the Talmud recorded specific cases and discussions that were relevant to religious practices and laws. There are also cases of pathophysiology and medical care that are recorded in Tanach, including likely uses of artificial respiration and medical explanations of Goliath's easy defeat. The Talmud contains a detailed description of cranial surgery and possible reasons and remedies for the gastrointestinal problems experienced by priests of the Temple periods.

There are two well-known accounts in Tanach that can be used to illustrate the early use of artificial respiration. These narratives indicate that artificial respiration was used over a thousand years before it became an accepted and discussed form of medical assistance. The book of Kings I contains the story of Elijah and the Shunamite woman. In return for the kindness the woman displayed by hosting Elijah, she was informed that she and her husband would be granted a child. However, when the child was just a young boy, he became sick and died. When the Shunamite woman approached Elijah for help, he "stretched himself upon the child three times and cried unto the Lord... I pray thee, let this child's soul come back into him" (I Kings 17:21), and the child came back to life [1]. Radak, a 13th century Biblical commentator, explains that the purpose of lying on top of the child was to warm him and to breathe life into him [2].

A similar situation is presented in the book of Kings II, which involves Elijah's student Elisha. Like his teacher, Elisha promised a child to a barren woman in the town of Shunam as thanks for her hospitality. However, the child died at a young age. While there is some speculation as to the source of the child's death, it is thought to have been caused by sunstroke [3]. The child was revived when Elisha "lay upon the child, and put his mouth upon his mouth, and his eyes upon his eyes, and his hands upon his hands..." (II Kings 4:34-35) [1]. Radak again interprets the purpose of lying upon the child as an attempt by Elisha to warm the boy with his natural body heat in an effort to revive him. Dr. Fred Rosner, a respected medical ethicist, concludes that these two instances are both describing mouth-to-mouth resuscitation [2].

Another incident in Tanach that warrants study from a medical perspective is the story of David and Goliath. How was it possible for David, a small shepherd boy, to defeat a giant, who was also an experienced warrior, with just a slingshot and a pebble? The text reads: "David put his hand in his bag, and took thence a stone, and slung it, and smote the Philistine in his forehead; and the stone sank into his forehead, and he fell upon his face to the earth" (I Samuel 17:49) [1]. Dr. Stanley Sprecher, a specialist in nuclear radiology, reports that the cause of Goliath's death was much less straightforward than it appears in the text. He explains that Goliath grew to be so large because he suffered from a pituitary macroadenoma (a large tumor), which resulted in acromegaly, a syndrome caused when a benign tumor on the pituitary gland secretes excess amounts of growth hormone [4,5]. Among the common symptoms of this condition are visual deficits, which are caused by the tumor applying pressure on the optic chiasm, the area of the pituitary gland through which optic nerves pass through to the brain, and an enlarged paranasal sinus, which is a group of air filled spaces around the nose and eyes. This pressure often results in a thinned cranial frontal bone. Therefore, it is possible that Goliath's sight was hindered, rendering him unable to follow David's swift movements. Moreover, a thinned frontal bone can explain why the stone easily entered Goliath's skull. Sprecher postulated that the stone was lodged in Goliath's pituitary gland and caused a pituitary hemorrhage, resulting in excessive pressure on Goliath's brain and his eventual death [4].

Dr. Vladimir M. Berginer, a consulting neurologist at Ben Gurion University, presents an alternative theory to the cause of Goliath's death. Like Sprecher, Berginer believes that Goliath suffered from acromegaly and a visual deficit. However, he explains that the cause of Goliath's death was not the stone—it was simply a result of David cutting off the fallen giant's head. He theorizes that the stone merely caused Goliath to lose consciousness, which afforded David the opportunity to sever the giant's head. Berginer also suggests other factors that could have led to Goliath's simple defeat. He explains that either Goliath was slow and clumsy as a result of his great size and the heavy weight of his armor, or that Goliath had muscle atrophy or joint inflammation [6].

Another interesting malady mentioned in Tanach is the deadly bowel disease that affected King Jeroham, a 9th-century king in Jerusalem. The text reads: "at the end of his life... the Lord smote him in his bowels with an incurable disease... his bowels fell out by reason of his sickness: so he died..." (II Chronicles 21: 18-19) [1]. According to Dr. Liubov Ben-Noun, a family medicine specialist at Ben Gurion University, this is a description of bowel prolapse with an unspecified cause. Ben-Noun discusses a few theories of the possible cause of this unknown disease. However, based on the description of the disease within the text, she concludes that the king suffered from colorectal carcinoma, a type of colon cancer.

She explains that although this is usually a familial disease, there are no indications that any other family members had this disease, and colorectal cancer is one of the only incurable diseases that primarily affects the bowels. She expands on this diagnosis by using the Dukes rating scale for rectal cancers to assess the severity of the cancer, ultimately concluding that the king's cancer must have been on the fourth stage of the scale—the final and worst stage. The Dukes scale ranges from a small cancerous polyp within the inner lining of the bowel in the first stage, to a large malignant cancer spreading from the bowel to other parts of the body, including the liver and lungs, in the fourth stage. From this diagnosis, it is possible that the “malignant, incurable course” the cancer took caused it to spread to the king's lymph nodes, and possibly to his blood [7].

The cases in the Talmud are presented in a different format than those in Tanach. Instead of stories and narratives, Talmudic cases are often presented as discussions regarding laws and ancient practices. There is a descriptive and detailed case of a cranial surgery in the Talmud (Ketubot 77b) presented in conjunction with a discussion of situations and professions that are grounds for a divorce. The Talmud explains that there are certain diseases that provide a woman the right to have a lawful divorce from her husband. One of the diseases listed is called ra'atan. Among the symptoms of this disease is severe discomfort caused by the skin being painful to the touch, as well as easy skin breakage. As a result, a husband would refrain from having intimate relations with his wife, thus violating the duty of a husband to satisfy his wife sexually, one of the contractual obligations found in the ketuba, the marriage contract. The Talmud explains that the debilitating symptoms could be stopped and the marriage saved with an invasive cranial surgery. It should be noted that the Talmud does not condone invasive, dangerous surgery unless it was truly warranted. The Talmud details the surgery itself, the environment in which it should be done, the anesthetics that are to be used, the materials required, and the recovery period [8].

Ra'atan can be interpreted as a growth that rests on the meninges, the protective membrane that covers the brain and spinal cord. In ancient Jewish texts it has been described as a form of boils. According to Rosner, however, it could be a form of leprosy or a reference to an insect in the brain. It is listed as the most harmful of all skin diseases in the Talmud, possibly because it affects potency (Vayikra Rabbah 16:1) [9]. Aside from skin lesions, symptoms include teary eyes, a runny nose, foam at the mouth, and flies swarming around the victim. The Talmud reads like a surgical manual describing how the tumor should be removed. The instructions state that the patient should be taken to a house made out of marble with no draft, or a house with incredibly thick walls. This ensures a sterile and clean environment. The Talmud then lists ingredients for a balm to be used before and after the surgery to “soften the skull.” These preliminary procedures were surprisingly redolent of modern antisepsis or anesthetic procedures [8]. The use of this balm, over a thousand years before the introduction of antisepsis treatments to surgical practices in the 1800s, indicates that the writers of the Talmud already understood the concept of infection and disease prevention [10]. The first ingredients listed are wormwood and pennyroyal, comparable to a mixture of

wormwood and rosewater that was introduced in 1170 CE as a mixture to help with blood clotting during cranial surgery. After the balm is applied to the patient's head, the surgeon must tear open the skull to expose an “organism” that rests on the meninges [8]. While both Weinberg and Rosner discuss that the organism could be a reference to an actual living, parasitic insect, Rosner explains that it is possible that there was no insect; the “organism” could have been nothing more than a growth or tumor [9]. In any case, once the “organism” was revealed, the surgeon used four myrtle leaves to lift each end of the growth, removed it with a pair of tongs, and burned it completely. If not burned completely, the growth would return [8].

The Talmud also contains accounts of personnel appointed to treat medical ailments during the Temple period. Ben Achiya was a Second Temple official who treated the gastrointestinal (GI) disorders of Jewish priests. Dr. Leonard Hoening, an internist, expounds on the many GI ailments experienced by priests and their possible origins. He explains that these problems were caused by the priests' working conditions and the food they ate. The priests had a specific uniform that they were commanded to wear when performing their priestly duties; however, these pieces of clothing were not always appropriate for their working conditions. The medieval commentator Rambam, who was also a physician, explains that the Priests wore the same uniform throughout the year, and the clothing was not always sufficient to protect them from the weather. The Talmud posits that the priests were prone to GI problems because they were forbidden from wearing shoes in the Temple, and the cold floor beneath their bare feet chilled them. Priests were also required to consume large quantities of sacrificial meat within small periods of time. Though the Talmud does not specifically comment on whether or not the heavy meat diet had an adverse effect on the priests, it is possible that because of the time constraints the meat was not always adequately cooked or cleaned, causing adverse effects on the GI system as well.

Ben Achiya used his vast knowledge of both herbal medicine and the positive effect of specific wines on the GI system to help the Temple priests. The Talmud comments that old wines, in moderate quantities, had the ability to help with stomach issues. Modern medical scholars have discussed these ideas as well. It has been proven that the ethanol in wine stimulates gastric secretions to help with digestion, and certain pigments in wine have the ability to help treat intestinal infections [11].

The aforementioned theories and accounts provide the ability to better understand the descriptions of specific illnesses in both Tanach and the Talmud through the lens of modern medical knowledge. Though details given in textual descriptions are often limited in regards to the causes and symptoms of specific diseases or pathophysiologies, these narratives provide an opportunity to examine interesting and plausible modern medical theories with regard to ancient afflictions. They also provide evidence of advanced techniques used by biblical and Talmudic personalities to provide healing interventions that may have been unknown to the greater scientific community of their time.

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## Opus Number Eight

Jessica Rousset

“A person should not say that music is not Torah, or it is Torah” (Midrash Shochar Tov). Music, as seen from the previous quote, is at the core of Jewish values and Jewish spirituality. Growing up, we sing Jewish songs about the stories in the Torah, some of these times as a way to remember stories such as the ten plagues. In the times of the Beit Hamikdash, the Leviim led their service with music and, even today, songs guide our holiest of prayers. Music is present at shul during the davening, at our bar and bat mitzvahs, as we thank G-d for our food, and so on, essentially in every aspect of our lives. Dovid Hamelech, one of the most revered kings of our nation, intertwined music into all areas of his life, most notably in his connection to Hashem. We find references to music throughout the Torah, ranging from Miriam leading the Jewish nation in Az Yashir after escaping the Egyptians, to the kinor, a musical instrument in the Temple, to the songs in Tehillim. Music is the string that connects them all [1]. The presence of song is what reaches out and connects the Jewish woman of the 21st century to the Jewish woman suffering through the slavery of Egypt. By these testimonies, one would think that music is to be exalted and always present in Judaism, but sages and explanations of the text have placed limits on its use. Seemingly, music and song have brought nothing but positive outcomes to the Jewish people. If this is truly the case, why are the prohibitions against it so severe?

The Gemara (Gittin 7a) states that after the churban bayit, it was forbidden to sing, play or listen to music. Furthermore, as noted in Mishna (Sota 48a), after the dissolution of the Sanhedrin, singing at parties was forbidden as well. Chazal debated as to what the Gemara and Mishna really meant in these contexts. Rashi and Tosfot agreed that in both cases, the music being referred to was only the music at feasts or parties. Many rishonim, including the Smag, agreed. However, the Rambam, or Maimonides, a prolific Torah scholar in the early 12th century, understood the prohibition to mean that music from musical instruments was always prohibited, whereas singing was only prohibited in instances in which wine was present [2]. Seeing the abundance and ever-present nature of music throughout Jewish history, these prohibitions seem incongruous.

The Yerushalmi's commentary in Sotah explained that these rabbinical prohibitions came as a direct result of the dissolution of the Sanhedrin. The Sanhedrin instilled a sense of awe in the people of Israel, ensuring that the Jewish people would act according to the laws set down by the Torah. Once the Sanhedrin was no longer in power, it was feared that song would become impure and would lead to frivolous acts, eventually bringing the Jews to sin. This is where Chazal reanalyzed the issur of singing and music, concluding that the issur only applied in situations with wine, such as a feast or a party, for example. According to this explanation, singing and music in other circumstances should be permitted [3]. Yet, the Rambam suggested that the ban on music was a sign of mourning for the destruction of the Beit Hamikdash and thus applied in all

circumstances, whether or not wine was present. Rav, also known as Abba Arika, and Rava, also known as Abba ben Yosef bar Hama, were both among the first amoraim and held stricter opinions, justifying this issur by stating that a person was given ears to listen to words of wisdom, and listening to music was an unproductive way to spend time [2]. Most Jewish communities in our day and age do not hold by this school of thought, although some Hasidic sects, such as the Satmar sect, abide by it.

The language describing music develops somewhat harshly in the Gemara. Rav states that “an ear that listens to music should be torn loose” (Sotah). Although the previous statement expresses a rigid approach, when the happiness of a kallah and chatan are a focal point at weddings, the commentaries agree on leniency. Weddings allow for both singing and instrumental music, despite the fact that wine is often served. Certain explanations even encourage music at weddings. The Rema, better known as Rav Moshe Isserles, a prominent rabbi, posek, and Talmudist of the 16th century, adds that if a seudah of a chatana is on a Friday night, one is permitted to ask a non-Jew to play music or even to fix an instrument on Shabbat, which is normally considered an issur deoraita [2]. It seems that, as strict as the poskim are about music on a regular basis, when it came to weddings, all the issurim were set aside. Chazal recognized that a wedding feast with wine and singing, along with men and women intermingling, had the potential to evolve into a frivolous, vulgar scene, threatening the sanctity of marriage. Still, the issur of listening to music and singing was suspended for the wedding [3]. Enhancing the simcha of the bride and groom was put above all else. Why was the happiness of a chatan and kallah put above the issur of playing and singing music?

It is clear that, although the laws of music are strict, there is a certain importance that surrounds weddings, which invites the magic of music to enhance the joyous event. In this exception, the reasons for such strict prohibitions begin to unravel. Chazal understood the power of music, and perhaps to that end, they chose to restrict it. Music is the intangible power that transcends the physical and glimpses into the spiritual. It is the medium through which we can look into the past, but also leave a legacy for the future. Music and song can arouse happiness, joy, sadness, grief, or any range of emotion within the religious community as well as the secular world. In an attempt to capture the emotional capabilities of music, Beethoven said that “music should strike fire in the heart of man and bring tears to the eyes of women.” Aside from the emotional aspect, the Gemara (Arachin 13b) alluded to music as having a connection to the world-to-come: “The kinor of the Temple had seven strings...and the one in the times of Moshiach will have eight...” The musical scale has seven notes and if one looks deeper into kabbalah, seven is representative of the outer parameter of holiness in this world [4]. Eight signifies the era of Moshiach, a time when the Jewish people will be redeemed, with this parallel being shown through music with the eight notes on

an octave scale. The eighth day, or era of the Moshiach, will bring about new perceptions and expanded consciousness; something entirely novel will be brought about with this eighth string, this eighth note.

How do mothers use candy in a positive way? They rationalize by using candy as a reward for good behavior on special occasions, thereby giving candy more value and making it special in the eyes of their child. Just as limiting candy makes it infinitely more special for the child, so too with music. Although the Sages restricted people from listening to music as a sign of mourning and out of fear of lewd behavior, there was a notion of keeping music and its hidden power as “candy” for the Jewish people. Music was to be used in celebration, and in circumstances worthy of its mysticism.

All restrictions of music are put aside for weddings, to rejoice in the partnership of two souls, the holiest of unions and a rite of passage in life. Music is the means by which we praise Hashem, reach out to Hashem in prayer, and repent through song. Music is the strand that connects us through generations and unites us as a nation. When Jews of all backgrounds, nationalities, and ages, at all levels of religiousness, join together to sing the Hatikvah on Yom Haatzmaut, the feeling of unity is unmatched by anything else. Chazal understood this. In efforts to hold on to this unique influence, ensure its continued spirituality, and not revert it into the mundane, our Sages took upon themselves to make a fence. They made a fence to keep our seven notes sacred until we should merit the redemption, ultimately revealing our eighth note.

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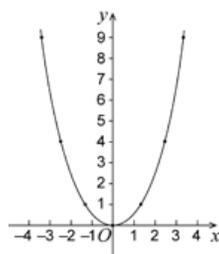
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# A Torah Basis for Limits and Mathematical Infinity

Miriam Saffern

Like a magnet drawn toward two poles, man oscillates within a dialectic that pervades his entire being. God imbued man with this inner tug-of-war the moment He formed his body out of the dust of the earth. HaRav Joseph B. Soloveitchik ascribes Rashi's dual commentary on the words "וַיִּצַר ה' אֱלֹקִים אֶת הָאָדָם עֵפֶר מִן הָאֲדָמָה" (Bereishis 3:6) as the source for this dialectic. First, God created man using the dust of all four corners of the earth, deeming man "cosmic," as the Rav puts it. With the cosmic mindset, man embarks on a quest to discover the endlessness of the world in three ways: through his pursuit of vast knowledge, through his emotional desire to experience all of the world, and through his movement away from home and adaptation to new surroundings [1]. To behold only this perception of his reality, however, would be contradictory to a Jewish existence. Thinking that he can grasp endlessness and vastness would be a fatal flaw, because man is finite and earthly: he has limits.

In mathematics, there is a parallel concept called a limit. A limit is a description of the behavior of a graph, which shows that  $f(x)$  becomes arbitrarily close to a number  $L$  as  $x$  approaches a number  $c$ . This is denoted by  $\lim f(x) = L$  [2]. For example, when the function  $f(x) = (x^3 - 2x^2)/(x - 2)$  is graphed on  $x$  and  $y$  axes, it looks like this:



The two arrows at the edges of the parabola indicate that the graph continues on indefinitely. Despite that, if we were to say that  $x$  approaches 2 from the right and the left, the limit would be 4. This can be found numerically by constructing a table of values of  $f(x)$  as  $x$  becomes arbitrarily closer to 2.



$x$	1.99	1.999	1.999	2	2.0001	2.001	2.01
$f(x)$	3.9601	3.996001	3.996001	?	4.00040001	4.0401	4.0401

As  $x$  approaches 2,  $f(x)$  approaches 4.

In Rashi's second explanation of the pasuk in Bereishis 3:6, he shows that God collected the dirt from one specific spot, the site of the future Beis Hamikdash, and molded it to create "origin-minded man." In this respect, man remains connected to his origin and eventually returns to it. Though opposite in nature, both the origin-minded and cosmic consciousness compel man to seek God.

When man, majestic and cosmic, searches for endlessness, it is there that he finds God in the grandeur and farness of His infinite nature. In contrast, origin-minded man meets God in the closeness and finiteness of a single spot [1].

This description of God being both majestas Dei and humilitas Dei begs the question: how could Hashem be both finite and infinite [1, 6]? Before we answer this question, let us describe the infinite nature of God as expressed in Torah.

In the tefillah of Adon Olam, written by Kabbalist Rav Shlomo ibn Gabirol, Hashem is praised as the Master of the Universe, One Who is "timeless, infinite, and omnipotent." Specifically, the words b'li raishis b'li tachlis, that Hashem is without a beginning and without an end, express the fact that He is infinite and does not conform to any laws of nature. A similar concept is packaged into the fourth of the thirteen principles of emunah, which acknowledges that Hashem is the first to exist and the last to exist. In other words, Hashem is the only One that can be infinite [3].

Though these statements clearly show that Hashem is infinite, the concept of infinity itself is still difficult to grasp. A pasuk in Yeshaya divides the concept into three understandable parts. In Yeshaya 6:3, Hashem is referred to as "kadosh kadosh kadosh Hashem tzvakos." At first glance, the repetition of the word kadosh seems extraneous. However, based on Rabbi Avraham Sutton's interpretation of the Targum, the words in fact reflect the infinite nature of God as being threefold: He transcends space, He transcends time, and He is so great and exalted that He is even beyond the comprehension of the heavenly angels [4]. A further discussion of mathematical infinity can elucidate these three concepts of Hashem's infinite nature.

In the study of limits, there are three limits that fail to exist, two of which are pertinent to our discussion. The first is a function which, as  $x$  approaches a specific value, approaches one point from the left and a different point from the right. The function  $(\text{abs}(x))/x$  is an example of this. As  $x$  approaches 0 from the right, the function nears 1, but as  $x$  approaches 0 from the left, the function nears -1. Plug in arbitrary values for  $x$  that approach 0 from each direction, and it becomes clear that the limit differs from the left and the right [2].

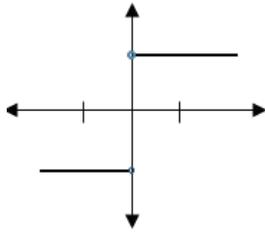
$x$	4	3	2	1	.5	.1	.01	.001	.0001
$f(x)$	1	1	1	1	1	1	1	1	1

$x$	-4	-3	-2	-1	-.5	-.1	-.01	-.001	-.0001
$f(x)$	-1	-1	-1	-1	-1	-1	-1	-1	-1

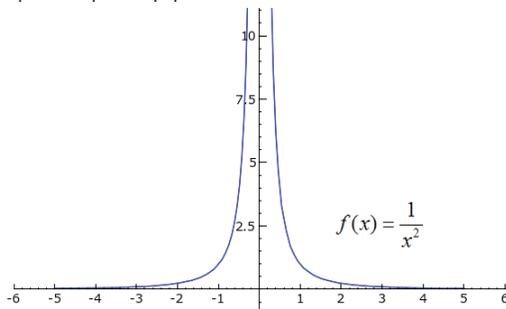
As depicted in the table, all positive values of  $x$  give the function a value of 1, and all negative values of  $x$  give the function a value of -1. Since there is no one distinct value that defines the function as  $x$

approaches 0, the function has no limit as  $x$  approaches 0 [2].

The graph of the function also shows that as  $x$  approaches 0,  $y$  approaches both 1 and -1, which proves that the limit of  $(\text{abs}(x))/x$  as  $x$  approaches 0 does not exist.



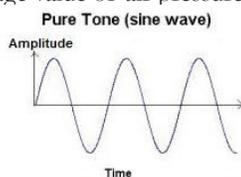
The second type of limit that fails to exist is one for which  $f(x)$  does not approach a specific number  $L$  as  $x$  approaches a given number  $c$ . In other words, the function increases or decreases indefinitely, so there will be a point  $c$  for which the function does not have a limit. The graph below displays such behavior with the function  $f(x) = 1/x^2$ . When  $x$  approaches 0,  $f(x)$  continues to increase and does not reach a specific point [2].



This introduces the concept of infinite limits. An infinite limit is a limit in which  $f(x)$  becomes infinitely large or small as  $x$  approaches  $c$ . Using this definition, the limit of  $1/x^2$  as  $x$  approaches 0 can be written as  $\lim_{x \rightarrow 0} 1/x^2 = \infty$ , where  $\infty$  symbolizes infinity [2].

Both limits described above do not exist because for neither of the functions does the  $f(x)$  approach a specific number  $L$  as  $x$  approaches  $c$ . The fact that Hashem transcends space helps draw a distinction between the two types of limits described above. Just like Hashem is not confined to one concrete spot, so too the limit of the first function as  $x$  approaches 0, if it existed, would be in two places at once. In the natural world, it is impossible for an object to be in two places at the same time (see graph of  $(\text{abs}(x))/x$ , whose limit fails to exist). But Hashem, on the other hand, Who is not bound by space, has the ability to be in two places at once. He therefore has no end, which is comparable to the limit of the function  $f(x) = 1/x^2$  as  $x$  approaches 0. There, the function will approach the  $y$  axis but will never actually reach it (see previous graph).

The study of music can explain the second concept of Hashem's infinitude, His transcendence of time. A special type of sound wave, called a pure tone, can be represented by a single sine wave. A sine wave is a function of time in which the curves rise and fall between some average value of air pressure [5].



According to French philosopher Francois Marie Charles Fourier, the sum of several pure tones, or sine waves, denotes a sound. The sine waves that comprise the sound are whole number multiples of the lowest frequency wave. A component of a sound wave with a specific frequency  $f_0$  is said to be the fundamental of that wave. Each successive component of the wave, with frequency  $nf_0$  where  $n$  is an integer greater than one, is referred to as the  $n$ th harmonic. To accurately portray a sound wave using Fourier's theory, it is necessary to add an infinite number of harmonics. However, mathematicians use a finite sum to create a close depiction of the wave. In theory, a Fourier integral, which adds the harmonics that comprise the sound wave, can accurately represent a sound wave. Yet, in truth, a musical sound does not last forever—it eventually ceases. Therefore, using sine waves, which continue on indefinitely, to represent a finite sound would violate mathematical theory [5].

Mathematicians explain this pitfall by saying that simply the idea of sine waves, not the accurate representation of them, is used to analyze sound [5]. I would venture to say that this mathematical artifice can be explained by the fact that Hashem is the only One Who transcends time. Since sound is natural, and is therefore bound by time, the Fourier theory is not entirely flawless.

Now that the two main concepts describing the nature of the infiniteness of Hashem have been established, let us attempt to use mathematical theory to elucidate the third concept of His infinitude by reconciling a statement in the Gemara that opens an even more baffling question regarding the infiniteness of Hashem. In Daniel 7:10, Daniel recalls a dream in which he witnessed the angels hovering beside Hashem's throne and serving Him. At that moment, there were one million celestial beings serving Him, and altogether ten thousand times ten thousand under His power. A seemingly contradictory observation is documented in Iyov 25:3: "Is there any number of His armies?" These words reflect the infinitude of Hashem's army, unlike the phrase in Daniel, which records an exact number. The Gemara in Chagiga 13b resolves the contradiction by noting that the *pasuk* in Daniel refers to the number of angels within one troop, and the *pasuk* in Iyov refers more generally to Hashem's troops, which are endless and have no number. However, we are still left with an enigma. Clearly Hashem is greater than everything and is far superior to his servants, so how can his troops be infinite if He is infinite? Put in other terms, is it possible that there is more than one level of infinity [6]?

In mathematical terms, infinity, denoted by  $\infty$ , is a quantity that is greater than any finite quantity. A set of numbers is infinite when there is no last number. For example, the set of all positive integers is infinite, because it consists of the numbers 1, 2, 3, 4, and so on and so forth, indefinitely. Georg Cantor, who pioneered the study of mathematical infinity, called this set  $\aleph$ . A set that contains all the squares of integers,  $\{1, 4, 9, 16, \dots\}$ , seems to have fewer elements than  $\aleph$ , as it does not include integers which are not perfect squares, such as 2, 3, 5, and 6. However, that would only be true if the two sets were analyzed by matching a number in one set with the identical number in the other set. 1 in  $\aleph$  would be paired with 1 in the set of squares of integers, and similar pairs of identical numbers would follow for the numbers 4, 9, 16, and so on, and the non-square integers 2, 3, 5, 6, and so on, would not have a match in the set  $\aleph$ . On the other hand, if each integer in  $\aleph$  was paired with its corresponding square in the set of squares of integers, the

result would be a one-to-one ratio between the elements in  $\aleph$  and the elements in the set of the squares of integers. The table below shows such a correspondence, which was discovered by Galileo Galilei [6].

1	2	3	4	5	6	...	N	...
1	4	9	16	25	36	...	$N^2$	...

Based on this idea of one-to-one correspondence, a countably infinite set can be defined as any set whose elements can be paired with the elements in  $\aleph$  and will result in a one-to-one ratio. Such a set is said to have the same number of elements as is in  $\aleph$ , denoted by  $\aleph$ . The set of squares of integers, as described above, is therefore countably infinite set with  $\aleph$  elements [7, 8]. Conceptually, countable infinity can be compared to the number of stars in the sky [7]. Though the number of the stars is infinite, each star can be assigned a number (see Rashi Shemos 1:1) from the set  $\aleph$ , resulting in a one-to-one correspondence with the elements in  $\aleph$ . Therefore, there are  $\aleph$  stars.

In addition to countable infinity, there is another type of infinity, called uncountable infinity. Any set that is not countably infinite is said to be uncountably infinite. Such a set is the set of all real numbers, which is greater than mathematical infinity and thus does not conform to the rules of mathematical infinity. One rule of mathematical infinity dictates that for any set X, there is another set, P(X), or the power set, which consists of all the subsets of X. For example, if there is a set  $X = \{1, 2, 3\}$ , which contains three elements, there are  $2^3$ , or eight, possible subsets:  $\{1\}$ ,  $\{2\}$ ,  $\{3\}$ ,  $\{1, 2\}$ ,  $\{1, 3\}$ ,  $\{2, 3\}$ , the set itself, and the empty set. The power set therefore has a greater number of elements than the original set because if N is the number of elements in X, there exists  $2^N$  elements in P(X). Put simply, for every set  $\aleph_0$ , there exists a greater set. This does not hold true for uncountable infinity. Since an uncountably infinite set consists of everything that exists in mathematical theory (i.e. all real numbers), it is impossible for any greater set to exist. Similarly, Hashem consists of everything that exists, so there is nothing greater than Him [6].

This answers our above question in the affirmative; there are indeed two levels of infinity. Countable infinity is signified by the Heavenly angels, and uncountable infinity is represented by Hashem. The third aspect of Hashem's infinite nature, that He is so great that He is even beyond the intellectual grasp of the angels, as described above in Yeshaya 6:3, is also illuminated. We see through uncountable infinity that Hashem is the paradigm of greatness: that He is the set of all sets, that He is essentially all that exists. Finally, the concept of uncountable infinity answers our original question regarding man's communion with God in both finiteness and infinitude (i.e. how can Hashem be both finite and infinite?). Just like the uncountably infinite set consists of all finite sets, Hashem, Who is the ultimate infinity, is also the totality of everything natural and finite.

In Derech Hashem, the Ramchal relays that fundamental to our belief in the existence of God is the knowledge that we can never fully understand His true nature. Hashem is incomparable to anything physical, and so we cannot even come close to understanding His nature [9]. This is summed up in the third principle of emunah, in which we proclaim, "I believe with perfect faith that the Creator—may His name be blessed—is not physical, and cannot be perceived by physical means, and there is nothing at all to which He can be compared" [10]. The whole notion of Hashem is shrouded by abstract concepts which are beyond the grasp of human intellect. If a person thinks he can comprehend Hashem's infinite nature, he is once again falling prey to the warped perception that he maintained as a solely cosmic man: that he can understand boundlessness and vastness. What makes the concept of God so difficult to comprehend is the fact that there are no physical terms through which to describe Him. Even mathematical limits and infinity cannot fully describe Him. Rather, the fact that Hashem is infinite shows that mathematical concepts can be derived from Torah. Though we can never comprehend what Hashem is, we will always know that He did exist, does exist, and will exist, everywhere [10].

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## Mei Teveryah in Rabbinic Literature: Medical and Halakhic Issues

Michal Schechter

The practice of hydrotherapy is a longstanding historical tradition, with recordings of the therapeutic use of water in Egyptian, Greek, and Roman societies. While the medical merits of the therapeutic use of water have long been debated, its popularity has remained constant, and thousands of people all over the world flock to various hot springs to benefit from their unique properties [1]. These hot springs, formed by water that rises from rock deep in the earth, are heated by geothermal heat. Each spring has its own combination of minerals and surrounding rock formations, such that different springs offer particular medical benefits. In Israel there are a number of well-known therapeutic springs, which are often referred to in rabbinic literature as *mei teveryah*. While this term literally translates as the “hot springs in Tiberias,” it is used as a general term for all hot springs. Rabbinic writings from the Talmudic period and their contemporary non-Jewish sources indicate that it was common practice for people to bathe in and drink from the waters of these therapeutic springs and baths. These spring waters were widely believed to cure general weaknesses of the body, treat internal problems, and heal various skin disorders. In response to the wide-spread use of therapeutic springs, the Jewish sages discussed both the medical and halakhic issues concerning *mei teveryah*.

Recent scientific studies on the effects of drinking mineral water from hot springs have confirmed their effective medical properties, many of which were discussed in rabbinic literature. In Tractate Shabbat (110a), the Rabbis explained that such water was called *mei deqarim* or *mei deqalim*. While explaining the origin of these names, the Talmud related that, “Those who say ‘*mei deqarim*’ refer to the piercing of the gall bladder; those who say ‘*mei deqalim*’ refer to the water which goes out from between two date palms. What is ‘*mei deqalim*’? Rabba bar Barona said: There are two kinds of palms in the west [of Israel] and a spring of water goes out from between them. The first cup loosens; the second induces diarrhea; and the third passes out just as it enters.” The rabbis recognized that these mineral waters had the ability to treat internal problems and help prevent constipation. Later on in the same Tractate (147b), the rabbis related that these waters were effective only between the holidays of Passover and Shavuot. It is possible that the springs only produced water with a high concentration of minerals during this time interval.

Various discussions centered on the halakhic aspects of using these mineral waters as a strong purgative substance. In a discussion of the therapeutic activities that were prohibited on Shabbat, the Mishna (Shabbat 14:3) related that, “Any food that a person eats for therapeutic purposes and any drink aside from *mei deqalim* and a cup of roots [are prohibited on Shabbat] because they cure jaundice. But it is permitted to drink *mei deqalim* for thirst...” Since the Mishna viewed mineral waters as therapeutic, it was prohibited to drink them on Shabbat. However, a person was allowed to drink

mineral water on Shabbat to satisfy her thirst. Unlike the Mishna, which prohibited drinking mineral water on Shabbat, the Tosefta stated that on Shabbat “one may drink ichor, *mei deqalim*, or a cup of roots.” It is possible that the Tosefta is referring to someone who drank spring water to reduce her thirst.

In addition to drinking from hot springs, people throughout the centuries have also bathed in hot springs, hoping to benefit from their therapeutic effects. The Tosefta on Tractate Shabbat (12:13) related that, “it is permitted to bathe in *mei teveryah* and in the Great Sea, but not in steeping pools and not in the Sea of Sodom [i.e. the Dead Sea]. When? When the purpose is therapeutic. If the purpose is ritual purity, bathing is permitted.” The Tosefta permitted bathing in therapeutic water on Shabbat only when it was common for healthy people to bathe there as well, so that bathing in such areas did not make it appear that the bathers were engaging in therapy. However, bathing in steeping pools or in the Dead Sea was totally prohibited, as the only purpose of bathing in those waters was for their therapeutic benefits. Rabbi Yaakov Sofer, a 20th century Jerusalem rabbi, wrote in his work *Kaf ha-Hayyim* that the prohibition of bathing in hot springs on Shabbat was meant for healthy people who suffer from slight maladies. He maintained that those who are seriously ill (even if their illness was not life-threatening) were permitted to bathe in therapeutic springs on Shabbat.

The common practice of drinking *mei teveryah* also gave rise to the issue of whether drinking these waters required a blessing, and if so, what blessing should be recited. The Mishna in Brachot (6:8) teaches that, “The blessing on drinking water when thirsty is *she’hakol nihye bi’dvaro*. Rabbi Yona said: Aside from *mei deqarim*. Rabbi Yosi said: Any water drunk for thirst. Rabbi Abbun said: Drinking *mei deqarim* requires the blessing *barukh she’bara mei refu’ot*.” Rabbi Yona believed that when the ingestion of spring water was intended for therapeutic purposes, one did not recite the blessing usually recited on drinking water. In opposition to Rabbi Yona, Rabbi Yosi believed that even when the ingestion of spring water was intended to satisfy a person’s thirst, the blessing of *she’hakol nihye bi’dvaro* was not recited. Rabbi Abbun commented that the end of the blessing over mineral waters required a special formula of *barukh she’bara mei refu’ot*. Rabbi Abbun seemingly felt that the blessing on mineral waters should reflect their health properties created by God. Interestingly, the question of reciting a blessing upon drinking spring water was not mentioned in the Babylonian Talmud, nor is it spoken about by the Rambam or Rabbi Yosef Karo.

Records of rabbinic responsa show that later rabbis dealt with the question of reciting a blessing on *mei teveryah*. In 1847, Rabbi Yaacov Etlinger was asked if a blessing was required upon drinking spring water for therapeutic purposes. In response, Rabbi Etlinger

wrote that, “we must make the following distinction [regarding different categories of therapeutic water]: drinking bitter water or tasteless well water for therapeutic purposes required no blessing. But drinking good-tasting water required a blessing even if drunk for therapeutic purposes. This is similar to any other good-tasting beverage that requires a blessing even if drunk for therapeutic purposes.” Rabbi Etlinger ruled that a blessing was only required when a person enjoyed the taste of the drink, such that therapeutic purposes did not impact the requirement for a blessing, as the blessing was recited over taste [2].

The therapeutic use of water continues to be popular today. People travel to hot springs and baths all over the world for relaxation purposes and as treatments for serious health conditions. The

effectiveness of medical treatments available from these waters can be seen in people with rheumatic diseases, lung ailments, and skin disorders, who regularly visit these springs as part of their healthcare regimens [3]. The medical benefits available in health springs have brought about various halakhic issues which are discussed in rabbinic literature. In regard to the prohibition of healing on Shabbat, the rabbinic consensus was to prohibit sources of water used only for therapeutic purposes. They additionally discussed whether a blessing over drinking the *mei teveryah* should be recited. It should be noted that this article does not discuss all the issues which may arise from the use of mineral water for therapeutic purposes, such as carrying towels to a bath on Shabbat, swimming on Shabbat, and mixed bathing [2].

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## Crown: To Wear or Not To Wear

Nora Shokrian

Chumrot are rulings which forbid certain actions in order to prevent sin, and they are central in Jewish law. Our rabbis have often set boundaries to reduce one's chance of committing great sins. Common examples include the laws of eiruv on Shabbat and the laws of kashrut.

Jewish law states that on Shabbat one may not carry, push, or pull objects from a private domain to a public domain, and vice versa. Included in this prohibition is carrying something in one's pocket or having an object in one's mouth. In modern times, the rabbis have strategically devised the concept of the eiruv in order to allow people to carry in a public domain. An eiruv encloses an area, combining the private and public domains into a single private domain. It can be man-made or occur naturally; however, it must be completed before Shabbat in order to be used during Shabbat [1].

There are many situations in which the rabbis set boundaries to prevent carrying during Shabbat. For example, a major issue in Jewish law deals with blowing the shofar on certain holidays. Although one is required to blow or hear the shofar on Rosh Hashanah, if the holiday falls on Shabbat, one is not allowed to blow or listen to the shofar. The Talmud gives a brilliant explanation for this: "Rabbah said: All are obligated to blow the shofar, but not all are skilled in the blowing of the shofar. Therefore, there is a danger that one will take the shofar and go to an expert to learn [how to properly sound it], and he will carry it four cubits in the public domain [—an act that is forbidden on the Shabbat]." To clarify, the Sages feared that a person who wanted to learn how to blow the shofar would carry it within the public domain on Shabbat, therefore they do not allow it to be blown on Shabbat at all. This restriction was enacted to prevent a sin from being committed. The Gemarah places similar restrictions regarding dental care in order to prevent carrying on Shabbat, thus thwarting the embarrassment of the sinner [2].

Sometimes, a tooth becomes very severely impaired because of decay, cracking of teeth, or trauma, and the area is too large to fix with an ordinary filling. In these cases, a crown would be an appropriate means of repair. A crown is the full covering of a severely damaged tooth. At times, it is put in as a preventative measure to protect a tooth from cracking or breaking [3]. The crown is a solid and strong replacement for a natural tooth. The procedure for inserting a crown starts with impressions of the tooth by a dentist. Next, the crown is made in a lab by following the outline of the model. It replicates the shape, size, and position of the damaged tooth. The process continues with cementation at the base of the gum, and finally the crown is inserted [4].

In the Mishna section T. Shabbat 6,5, there is a discussion regarding whether or not a woman is permitted to leave her home with a false tooth. At first, the Sages agree that she would not be able to

go out with a gold tooth. Their reasoning is that if it were to fall from her mouth, she would certainly need to pick it up because of its high value, and she would probably need to carry it more than four cubits in a public domain. As stated above, such actions are not permitted during Shabbat because one may not carry an object more than four cubits in the public domain. Most people would think that the ruling would be different if the tooth was made of a less expensive material, such as wood, because if it fell out of her mouth, the woman would not care for its cheap value and would not pick it up and carry it for more than four cubits. However, the Talmud does not agree, and notes that if the artificial tooth were to fall out, the woman would be too embarrassed to report to the technician that she lost the wooden tooth and needs to buy another one. Therefore, she might desire to pick it up and carry it four cubits in a public domain so as not to embarrass herself, which is forbidden on Shabbat [5].

The Mishna in Shabbat states, "An artificial tooth or a gold tooth... Rabbi permits but the Sages forbid." The Rambam defines an "artificial tooth" as "an unnatural tooth that a woman puts into her mouth in the place of a tooth that has fallen out temporarily and is strengthened by pressure from the adjacent teeth." He continues to interpret "gold tooth" as "a natural tooth, which is covered with gold in order to conceal a defect" [5]. Here, the Rambam is referring to a crown, a cover for a damaged tooth, instead of the replacement of a tooth [6]. On the other side of the spectrum, Rabbi Ovadia of Bartenura defines "artificial tooth" as "a tooth sitting in the gums in place of a tooth that has fallen out." He also defines "gold tooth" as "a tooth whose color has changed... and is covered with gold..." In this situation, Rabbi Ovadia of Bartenura is referring to a gold crown that covers a discolored tooth [5]. Rabbi Ovadia of Bartenura also describes that a "tooth with a changed appearance due to mold is covered by gold." What one may infer from this Mishna is that, in the days of Rabbi Ovadia of Bartenura, society believed that mold was the cause of tooth decay [6].

In another case, the Rambam adds that a woman may not go out on Shabbat "with a tooth that is in the place of a fallen tooth and not with a gold tooth... but with a silver tooth it is permitted because it is not recognizable" [5]. The Rambam interprets a "black tooth" as a non-vital tooth, a tooth that lost its color because of the staining of dentin by damaged blood cells following a hemorrhage in the pulp, which is the inner substance of the tooth. He also refers to a red tooth, which occurs when there is decay on the inner part of the tooth and the outside enamel layer is still intact. The blood vessels in the pulp may show a red color, and this color is visible through the thin enamel layer that is still left on the tooth [6].

In reference to the Talmudic discussion about whether or not a woman was allowed to go out on Shabbat with teeth made of a given material, Rabbi Meir and the Sages fiercely debate the

question of a gold tooth, but they agree that one may wear a silver tooth on Shabbat. Rabbi Meir says that a woman may wear a gold tooth on Shabbat, but the Sages do not permit women to go out with a gold tooth on Shabbat. They argue that the tooth would be extremely noticeable and flashy, and the Sages feared that a woman's friends would mock her, thereby causing her to take it out of her mouth and carry it in a public space, which is forbidden. On the other hand, a silver tooth is not as noticeable and should therefore be permitted [5].

While Rashi agrees that a gold tooth should not be worn on Shabbat, he has a different take on the issue at hand. Rashi explains that a gold tooth is extremely expensive, and a woman would desire to show it off to her friends. Therefore, she would take it out and carry it in a public space, which is not permitted during Shabbat [5].

There are many opinions expressed as to whether or not a crown may be worn during Shabbat. All of these opinions strive to prevent the sin of carrying in a public domain during Shabbat. However, they differ in their reasoning of why a woman would remove a crown from her own mouth. In one instance, it is because the woman might be embarrassed by the crown. In another example, it is because she would want to show it off to her friends. At the end of the day, the rabbis sought to set boundaries to prevent sins from being committed through forbidding gold crowns on Shabbat. All of the rules regarding whether a woman can wear a certain crown or not are chumrot. They were enacted so the situations mentioned earlier in this paragraph could be prevented.

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# The Roots of Contemporary Podiatric Medicine in Biblical Times

Rebecca Tabaroki

For thousands of years, patients around the world have suffered from various forms of illness and disease. Throughout the centuries, advancements in technology and modern medicine have enabled physicians to readily diagnose and treat their patients more efficiently. Although today the medical industry has become successful in its treatment of even the most severe illnesses, thousands of years ago, most medical professionals were not able to successfully aid their patients due to a lack of knowledge and an inability to access adequate medication.

Today, most individuals are stringent when it comes to taking care of their overall health. Many visit their dentist twice a year, are advent on getting an annual eye examination, and even visit their general physician on a biannual basis. However, when it comes to the health of individual parts of the body, the foot is the part of the body that is the most neglected. According to the American Podiatric Medical Association, “healthy feet are fundamental to the quality of our lives. They are wondrously engineered and often are the indicators of our overall health” [1]. Feet are the foundation on which the body stands and operates. Even early on, the foot can indicate signs of medical conditions that can be related to other syndromes, such as diabetes, arthritis, and circulatory and nerve defects. It is unfortunate, however, that many individuals are not aware of the importance of proper foot care and do not realize that early detection of many illnesses can be identified through periodic foot evaluations.

Although healthy feet are vital to one’s overall health, many people do not have a clear understanding of when it is important to see their podiatrist. A podiatrist is a podiatric physician and surgeon who treats and diagnoses syndromes of the foot, ankle, and related structures of the lower extremities [2]. Podiatrists treat a variety of disorders and conditions, including bunions, diabetic ulcers, hammer toes, flat feet, Morton’s neuroma, tendinitis, sports injuries, athlete’s foot and so forth. Dr. Gail Rucker, one of the leading podiatric physicians in Washington D.C., suggests that people should visit their podiatrist regularly, even if they are not experiencing pain [3]. Those with chronic medical conditions, such as diabetes, should take extra preventative steps in their foot care, since they are predisposed to many foot conditions. Even though tending to the health of one’s feet is not the first thought that comes to mind when thinking about living a healthy lifestyle, proper foot care and examination is a key standpoint to upholding a better standard of living.

The importance of maintaining healthy feet is not only palpable in the modern world. In Biblical times, there seems to have been much emphasis on the feet. During the times of King David (1002–970 BC), it is written that fifty men existed who had the soles

of their feet “carved out” [4]. Many scholars have attempted to interpret this phrase and most have come to the understanding that these men were members of the elite guard of David’s adversary, Adonijah [5]. In regards to these soldiers, Rashi (1040-1105) adds, “their soles were without flesh so that running on briars and thorns did them no harm” [4]. Even without the advancements of technology, medical professionals in the biblical era were able to comprehend the importance that the feet play during battle. They used the anatomy and mechanics of the foot and reconstructed it so that these men were able to run without tiring and become victorious. Undoubtedly, it is evident that even in this era the foot was recognized as significant and integral for the success of warfare.

King Asa, the third king of the house of Judah, ruled between 867-906 BCE. In the book of Kings I (15:23), it is said regarding King Asa that “in his old age his feet were crippled by disease.” Although many commentators have sought to discover the disease that afflicted King Asa, the true diagnosis is still a mystery. As noted in the text, Asa’s pain first developed throughout both his legs. The disease from which he suffered quickly advanced as he aged. Dr. L. Ben-Noun, a well-known scientific journalist, suggests that King Asa suffered from various foot pathologies, including gout, degenerative osteoarthritis, and peripheral vascular disease (PVD). Since PVD is frequently common in elderly males and is responsible for at least 95% of chronic leg ischemia, it is suggested that PVD was the most likely possible diagnosis for King Asa’s condition [6]. Asa’s illness eventually led to his death and downfall. While physicians of this era did not have the proper knowledge and technology to successfully treat King Asa for his podiatric disease, the application of podiatric medicine is illustrated, and furthermore, the importance of proper foot care is evident in the narration of Asa’s story.

Although the idea of foot health is not the first thought that comes to mind when attempting to lead a healthier lifestyle, healthy feet are fundamental to the quality of one’s life. Podiatric physicians are educated and certified to diagnose and treat a variety of conditions pertaining to the foot and lower extremities. Additionally, examples throughout history have demonstrated the important role that feet play in all aspects of life. Whether performing extensive surgery on warriors to reconstruct the anatomy of their feet or acting as the ruler of an empire while suffering from a painful foot disease, podiatric medicine has been relevant throughout time and continues to be significant in societal welfare today.

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# Compassion towards People with Disabilities: The Torah Perspective

Allison J Tawil

A disability, whether physical or mental, is the interaction between an individual's health condition and his or her environment. Disabilities are not an uncommon occurrence, with some manifesting themselves at birth and others developing later in life. According to the World Health Organization (WHO), over 1 billion people, or 15% of the world's population, are living with some sort of disability, using the broadest sense of the term. Included in this number are those with a physical disability, which encompasses difficulty in seeing, hearing, or walking, and those with forms of mental or intellectual disability, such as people affected by Alzheimer's, Down syndrome, or autism [1].

Understandably, people with disabilities require special accommodations to accomplish everyday tasks and lead fulfilling lives. It was not until fairly recently in modern society that their special needs have been recognized and accommodations made to help these individuals. For example, special education classes focus on providing instruction to children who would not succeed in the typical classroom setting. Special education was not a mandatory provision in American public schools until 1975 [2]. Up until 1990, it was not obligatory by American law to provide for public transportation, communication, or to make other areas of public life accessible to those with disabilities [3]. Without such accommodations, it would be very difficult for people with disabilities to succeed and lead as normal a life as possible.

While modern society has only recently recognized the special needs of individuals with disabilities, we can see that in many instances, the Torah has always been directing us to treat these people with respect, compassion, and an understanding of their special needs.

The first indication of this understanding is found in Vayikra (19:14), "You shall not curse a deaf person. You shall not place a stumbling block before a blind person" [4]. We are instructed not to take advantage of other people's vulnerabilities, namely those who cannot see. The Rambam, 12th century philosopher, astronomer, Torah scholar, and physician, points out that these pesukim refer not only to those who are blind in the conventional manner, but also include those who are blind in any aspect of life. He notes that every person has limitations in some aspect of life and, therefore, we must treat each person with the utmost respect [5].

For numerous laws in the Torah, it is indicated that having a specific disability would relieve that person from participating in the mitzvah. Although this may superficially be interpreted in a degrading manner, in all of these instances the Torah is in fact looking out for this person's benefit. By disqualifying or exempting participation in certain mitzvot, the Torah shows compassion towards the disabled and ensures that no one is harmed by an unrealistic requirement to fulfill specific mitzvot. It also ensured

that no guilt would be felt by those individuals who are not able to fulfill the mitzvot [6]. No one was forced to do something that would hurt or inconvenience them to a great extent.

When Hashem explained to Moshe the role of the kohanim, the Jewish priests who worked in the Beit HaMikdash, He enumerated certain disabilities that disqualify a person from performing a kohen's duties (e.g., offering korbanot). These disabilities include, "A blind man or a lame one, or one with a sunken nose or with mismatching limbs; or a man who has a broken leg or a broken arm; or one with long eyebrows, or a cataract, or a commingling in his eye; dry lesions or weeping sores, or one with crushed testicles" (Vayikra, 21:18-20) [4].

It seems cruel, and almost unfair, that such prestigious duties are withheld from these people due to their disabilities. However, looking deeper into the issue at hand, this prohibition is based on practical reasoning. The Beit HaMikdash is the ultimate place of holiness in the world. It is understood to be the connection between olam hazeh and olam habah. As workers in the Beit HaMikdash, kohanim hold the vital role of being mediators between these two worlds, and thus, of necessity, they must be very close to Hashem and His holiness. Hashem's holiness has the power to kill those who are not careful in its presence, as demonstrated by the story of Nadab and Abihu. Therefore, it is vital for the selection of kohanim to be completely tahor, born from a permitted marriage, and free of overt blemishes. These qualities were designated because this is the only form that a person would "fit in" in olam habah, and would therefore be the most protected from the holiness of Hashem. Of course these people are perfect in the eyes of Hashem, but every measure is taken so that nobody would be harmed by the extreme holiness of the Beit HaMikdash, that could kill even those who do not have bad intentions. Their job was dangerous and a simple mistake, even if with the right intentions, could cost them their lives. Kohanim with disabilities were permitted to eat from the korbanot, which proves that this prohibition was only with regard to working in the Beit HaMikdash [7].

Although the destruction of the Beit HaMikdash eliminated the fear of its lethal holiness, there still is this fear in another one of the kohanim's duties- Birkat Kohanim. Kohanim with disabilities are not permitted to participate in giving this blessing to their community. While kohanim recite Birkat Kohanim, the kohen's blessing to the congregation, it is said that the presence of Hashem resides over the kohanim. Congregants are advised to look away to avoid an encounter with this dangerous holiness that can kill them. It was feared that congregants would be tempted to stare at a physically disabled kohen giving the blessings. Additionally, it would not be ideal to distract members of the congregation during such a serious time of prayer [8]. Therefore, kohanim with blemishes were not permitted to participate in Birkat Kohanim. Oral law

included in the Tosefta pointed out that this included kohanim with blemishes on the face, hands, or feet [9].

However, the Tosefta also made an exception to this rule. If a community was familiar with a certain physically disabled kohen, he would be able to recite Birkat Kohanim, as the community would not be compelled to look at him (Megillah, 3:29) [7]. The Talmud concurs with the Tosefta and presents examples in which this exception comes into play. Among those examples mentioned is a kohen with spotted hands or who is blind in one eye. Both of these kohanim are permitted to recite Birkat Kohanim in their respective communities, since their communities are familiar with their disability and would not be distracted by it (Megillah 24b).

Another mitzvah from which people with disabilities are exempt is the requirement to travel by foot to Jerusalem three times a year for the shalosh regalim. Rashi interprets the usage of the word “regalim” to exclude “the lame, the sick, the blind, the aged, and those who cannot go up on foot.” Again, one may assume that this is a degradation of individuals with these disabilities, as they are missing this great opportunity of visiting the Beit HaMikdash. However, in actuality, the Torah was looking out for those who would have much difficulty carrying out this mitzvah. Exemption from a mitzvah is not the same as disqualification, and they were free to visit the Beit Hamikdash if they so desired [8].

The importance of creating special accommodations for students who do not learn in the typical manner is demonstrated by the Talmud’s aggadah about Rav Pereda, whose student needed teachings to be repeated 400 times before he remembered it. On one particular day, the student was not able to grasp a teaching after hearing it repeated 400 times, so Rav Pereda taught it an additional 400 times. After this, a bat kol called out and asked Rav Pereda if he would rather his life be extended 400 years or if he would prefer that his whole generation, including himself, would go to olam habah. Rav Pereda chose the latter, so Hashem granted him both (Eruvin 54b). Rav Pereda was rewarded for making such an effort to teach his student, which demonstrates the importance for teachers to make resembling efforts when teaching their students with special needs.

Rabbi Moshe ben Shimon Margolis, the 18th century author of Pnei Moshe and teacher of the Vilna Gaon, explains that teachers should teach students no matter their intelligence level or capacity to remember things. He derives this from Moshe Rabbenu. Moshe had a record of constant forgetfulness, but eventually he acquired knowledge and became the ultimate teacher of Torah. In the Talmud, Rabbi Yohanan recounts that during the forty days that Moshe was learning with Hashem on Har Sinai, Hashem taught him the Torah forty times, but after each time he forgot it (Nedarim 38a). This narrative brings Rav Yosef Soloveitchik, 20th century rabbi, philosopher, and Talmudist, to conclude: “If it is possible for Moses to be chosen as the messenger for the Holy One Blessed be He, it is possible for every single Jew.” Hashem can convey His messages through whoever He chooses, regardless of a person’s apparent limitations. Hashem will assist this messenger in comprehending the message that will be communicated [10].

A similar idea is revisited in the Passover Hagaddah, which relates a Midrash that discusses the four sons who are present at the Passover seder. The Midrash articulates the specific methods that should be used to teach each son about the miracle of yetziat mitzrayim, the exodus from Egypt. It explains how to teach the child who is wise, who is rebellious, who is simple, and the child who does not know how to ask. It is recognized that every child does not learn in an identical manner and some children require more individualized attention than others. Nevertheless, all children should be taught about the miracle. The Passover Hagaddah explains how to open up to each son based on his intelligence level and personality. Additionally, Rashi explains that it is no coincidence that the discussion of these four sons comes right after the section of “Baruch HaMakom Baruch Hu.” The connection is meant to be a praise of Hashem for giving us the Torah and making it accessible to all types of learners, even those who require special learning styles [11].

As such, Rav Moshe Feinstein, leading posek of the 20th century, ruled that the Torah education of children with mental disability is extremely important. Since accommodations for these children can be pricey, community charity funds should be set up to support their education. These children will learn at their own pace, nonetheless, if they have the capacity to learn then they definitely should [12].

In addition to making accommodations for the special needs of people with disabilities, the Hazon Ish, a 19th century rabbi, demonstrated the importance of providing a greater respect towards these people. The Hazon Ish, a former leader of Haredi Judaism in Israel, would stand up when a person with a physical or mental disability would step into a room. He would do this out of the belief that these people have special neshamot that belonged to righteous people who performed many mitzvot. These neshamot return to this world to make a few tikkunim, rectifications, so that they can reach perfection. Regardless of the reasoning, the Hazon Ish’s actions demonstrated a deep respect and reverence towards these individuals despite their disabilities [13].

Incidentally, Judaism’s compassionate and respectful treatment towards individuals with disabilities allows for most parents of children with disabilities to regard their children in a different light, thus facilitating a family’s coping with the disability. In other words, religion allows for a positive perception of disabilities in most families. As the mother of an autistic child put it, “His brain is damaged, that’s true, but the brain is only a physical component, the soul is the spiritual component, and this part is especially high in these children.” In Judaism, there are two aspects to a person, the physical and the spiritual. This leaves room for the belief that there is a higher spiritual level in those with limits in the physical world, such as those affected by a physical or mental disability. Additionally, thanks to the growing openness in the secular world towards disability, the stigma and shame that was once associated with having a child with special needs has been removed in the Jewish community [14].

As demonstrated by these examples, the Torah does not disregard the special needs of those with disabilities, but instead tries to

understand and accommodate the needs of these individuals. The Torah also indicates that we must not overlook or disrespect individuals with disabilities, and directs us to treat them in a compassionate manner. Indeed, the Torah's direction for proper treatment of those with disabilities contributes to the understanding that every person is important and has the ability to achieve regardless of their abilities or disabilities. It is no coincidence that

many of our past leaders had disabilities themselves. Yitzhak Avinu lost his sight later in life (Bereshit, 27:1). Yaakov Avinu walked with a limp after his struggle with an angel (Bereshit, 32:32). Moshe Rabbenu had a speech impediment (Shemot, 4:10). Needless to say, these individuals accomplished quite a lot in spite of their disabilities.

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# The Yom Kippur Effect

Rachel Weil

The most sacred day on the Jewish calendar is the fast of Yom Kippur. On this day of repentance, men and women are obligated to abstain from eating and drinking for 25 hours. Because of the sacrosanct nature of this day, the law is very stringent, and permission to break the fast is only approved in very dire circumstances. In its discussion about individuals fasting on Yom Kippur, the Talmud singles out pregnant women. In Tractate Yoma the Talmud states that if a pregnant woman has a craving on Yom Kippur we are allowed to give her food until she is satisfied (82a). This topic opens up a discussion about the degree of leniency granted towards pregnant women on the day of repentance. These leniencies are considered because of the possibility that fasting on Yom Kippur may induce early labor, potentially threatening the life of either the mother or the child.

Studies have been conducted to examine this hypothesis and test its validity. Soroka University Medical Center ran a study examining more than 1300 deliveries that took place both on Yom Kippur and during the corresponding day a week earlier between the years of 1988 and 2011. The study defined preterm delivery as delivery before 37 weeks of gestation. The results showed that a 25 hour fast is an independent risk factor for preterm delivery [1]. A similar study was conducted in Jerusalem on pregnant women. The delivery room records were studied according to a 15 day period subdivided into three groups: the 24-hour period immediately following the fast, the seven days before Yom Kippur, including the fast day itself, and the seven days after the fast. After the data was collected and analyzed, an increase in the delivery rate for the 24 hour period after the fast was observed. The increase in preterm deliveries was limited to the 24 hours after the completion of the fast for women who were at or near term [2].

Although there is no clear reason as to why fasting on Yom Kippur can cause spontaneous delivery, a possible factor might be due to the substantial rise in blood viscosity caused by total abstinence from food and water. This causes an increase in anti-diuretic hormone (ADH) secretion. The uterus' smooth muscle is very sensitive to ADH, and increase in the hormone is suspected to induce uterine contractions, resulting in premature labor [1]. This reason is highly plausible, especially if one examines a study done to test the effects of fasting on viscosity and the blood plasma. Blood was drawn from 29 participants just prior to the end of the fast. Results showed that there was an increase in blood cells and plasma proteins attributing to an overall elevated blood viscosity [3]. A second theory as to why fasting can cause early labor is due to the relationship between fasting and an increase in prostaglandin production due to the higher levels of free fatty acids. The prostaglandin also causes uterine contractions and results in premature labor [1].

These studies are not a basis to prohibit women from fasting; rather, women with a propensity for preterm delivery should be cautious about fasting for 25 hours. When it comes to determining if a pregnant woman should fast or not on Yom Kippur, rabbis will use these studies to help guide them in making the most appropriate determination for each individual case. Rabbi Yisrael Fisher, a member of the Bet Din of the Edah ha-Haredit, for example, permits pregnant women to eat on Yom Kippur upon experiencing "slight weakness." On the other hand, Rabbi Moshe Sternbuch, the deputy head of the Bet Din of the Edah ha-Haredit, believes that since fasting may only hasten parturition, but does not definitively present danger, pregnant women are obligated to fast. Only in extreme cases, where there is a clear and present danger, should they eat [4].

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## Strings of Blue

Stephanie Zerbib

Walking down the streets of any Jewish community, one may notice men with white fringes dangling down from their shirts, while other men are wearing fringes of both blue and white. This practice is in accordance with the mitzvah of tzitzis, ritual fringes or tassels worn by observant Jews. But where does the color difference come into play? Hashem said to Moshe, “Speak to the Children of Israel and say to them that they shall make themselves tzitzis on the corners of their garments, throughout their generations. And they shall place upon the tzitzis of each corner a thread of techeiles wool” (Bamidbar 15:37-38). The men wearing the plain white fringes are performing the mitzvah of tzitzis, and those with the fringes colored blue and white are observing the additional mitzvah of wearing tzitzis dyed with the color techeiles. However, due to the controversy surrounding the true color of techeiles, not everyone observes this additional mitzvah and wears tzitzis with a blue color. According to Rashi, the techeiles dye comes from an animal called the chilazon. However, there are two problems that need to be addressed: what animal is the chilazon, and what does the color of techeiles actually look like? Due to the advanced technology of this generation, we can use archaeology, marine biology, and chemistry, in combination with the great rabbinical minds of the past and present, to better understand these issues.

There is evidence that the 6th century Jews had the knowledge of how to make the techeiles dye and used it. During this time, the Jews living along the coastal region of Northern Israel and Lebanon were known for their dye industry. The main resources for their industry came from the sea. Chazal taught us that the chilazon was a treasure found only in the land belonging to the tribe of Zevulun. The land of Zevulun is in Northwest Israel, along the Mediterranean coast, lending support to the idea that this 6th century dye industry participated in the production of the techeiles dye from the chilazon. [1]. The Rambam states that the chilazon lives in the Yam Hamelach, now referred to as the Dead Sea. Yet, the Rambam also recounts in his Responsa that he “travelled on a boat on the salt sea.” It is extremely unlikely that the Rambam is speaking of the Dead Sea, since no boats travel on the Dead Sea. Furthermore, there is no life to be found in the Dead Sea. This leads us to believe that “the salt sea” most likely refers to the Mediterranean Sea. He called the Mediterranean the “salt sea” in contrast to fresh water seas [2].

Another issue that is debated is the true color of techeiles. Most authorities believe the color to be a shade of blue. Rashi states that the color of techeiles was yarok, translated as green. Yet, in Talmudic terms, the word yarok can include shades of blue as well. Looking at the Midrash that Rashi cites at the end of Parshas Shelach, we find Rashi’s interpretation of the color: “The color of techeiles is similar to the sky as it darkens toward evening.” This statement lends even more evidence that yarok does not mean

green here, as the above reference does not indicate a green of the sky. Rambam refers to it as “the color of the clear sky visible near the sun,” also indicating techeiles to be a shade of blue. Even further descriptions of varying shades of blue come from Chazal. Chazal teach that “Techeiles is reminiscent of the sea, the sea is reminiscent of the sky, and the sky is reminiscent of the Throne of Glory.” This can be interpreted to mean that the color termed techeiles, like the sea, is suitable for use in tzitzis, but the techeiles used in the building of the Mishkan is richer, similar to the sky. The richest techeiles of all is the techeiles that was used for the garments of the Kohen Gadol. All these scholars lead us to believe the true color of techeiles is a shade of blue [1].

The present dilemma of which animal and of the exact color is due to the fact that this information was lost to us when there was a tremendous upheaval of the Jewish community in Israel during the 17th century. Jews were being forced to leave their homes. The traditions and secrets of how to produce techeiles were lost during these rough times. The Jewish dye industry was destroyed, and after a few centuries the art of producing dyes from snails was lost. Therefore, we are now trying to use science to determine the proper method of extracting the dye from one possible animal found in ancient times, the snail. This technique of using snails for the color techeiles has been confirmed by the archaeological discoveries where large quantities of shells have been recovered from storage chambers. These storage chambers have been known to produce a “royal blue” dye for the highest ranking aristocracy [3].

With the information lost to us, different interpretations of the identity of the animal used to produce the dye have been proposed. The first interpretation, in the mid 1880’s, was given by Rabbi Gershon Henoch Leiner, also known as the Radzyner Rebbe. He believed that the animal known as the chilazon was the common cuttlefish. The cuttlefish has a gland that produces a dark ink-like substance called sepia which is black in color. This black color seemed to be confirmed by the Rambam, who commented that the chilazon has ink-black blood. However, the true color of the cuttlefish’s blood happens to be a greenish-blue color. This could suggest evidence that if the chilazon animal is truly the cuttlefish, perhaps it is the blood of the animal that is to be used instead of the sepia ink which it produces. Nevertheless, the Rebbe consulted with local chemists to determine a way to turn the color of sepia to blue. They suggested he add certain chemicals and boil it. This worked, yielding a blue color that could successfully dye wool blue. Not everyone agreed with this method of obtaining techeiles. In 1913, Rabbi Dr. Yitzchak Herzog took it upon himself to determine whether this cuttlefish dye could be the true techeiles dye. Part of the research towards his doctoral dissertation involved taking a sample of the Radzyner Rebbe’s talhit to leading chemists and dye experts in Germany, France, and England for analysis. These experts found the surprising result that the blue dye was

not organic in nature, as techeiles should be; it was an inorganic pigment called Prussian blue, or ferric ferrocyanide. The process used left no trace of the original sepia, except for the nitrogen atoms. This color, in fact, could be produced with blood from any animal and, thus, the cuttlefish ink was not an essential part of the process. Rabbi Herzog concluded that the cuttlefish ink was not the proper animal. He instead believed it to be a member of the *Janthina* species, a type of bubble-raft snail. This snail has a blue body and a blue shell. However, the prominent problem identifying this snail as the chilazon was that the dye produced was unable to dye wool blue. After a few hours, the dyed wool would turn dark brown. According to the Rambam this was problematic, as the identifying feature of techeiles was that once dyed, an item would never turn into another color [1].

The most recent thought to which animal the chilazon could be has been the *Murex trunculus* snail [4]. When Rabbi Herzog examined the possibility of the *Murex* snail being the elusive chilazon, he concluded it was unlikely for a few reasons. First, the snail's shell color was white. This did not fit with the Gemara's description of the color of the animal as "domeh l'yam," resembling the sea. However, the specimens he examined had been polished and cleaned. When *M. trunculus* shells are in the ocean, they are covered by a coating that has a blue or green coloring, which would fit the description of resembling the sea. Yam could also be interpreted as "sea bed," which perfectly represented the snail in its natural habitat. The other substantial reason for rejecting this option was that the dye obtained from the snail produced a blue-violet color and not the sky blue hue typically associated with techeiles. According to Jewish law, the chilazon cannot contain any tinge of violet [1, 3].

However, scientists have demonstrated that the dyestuff of the snail was composed of indigo, mono-bromo-indigo and di-bromo-indigo. Di-bromo-indigo presents itself as purple whereas indigo is blue. It was demonstrated that when the reduced solution of snail dye is exposed to sunlight, the UV-rays from the sun act to break the bromine bonds. When oxidation occurs following the removal of dyed fabric from the solution, pure indigo bonds to the wool, while the bromine atoms are left in the vat. The result is a pure blue color with no trace of purple [5].

Today, seeing men wearing white tzitzis confirms our commandment to observe the mitzvah of tzitzis, regardless of whether we have discovered the true chilazon animal. Regrettably, we still are not privileged enough to know whether we are correct or not in the assumption that the true chilazon animal is the *Murex Trunculus* snail. The Talmud recognizes this issue, and makes note that "the punishment for [not wearing] white [tzitzis] is greater than the punishment for not wearing techeiles" [3]. Looking towards the future, we can only hope that we will one day reach a high enough level to know the truth behind the techeiles. On the other hand, we have made significant progress to discovering what techeiles could be. From archeological evidence, we can deduce the possible ways the dye was made. Advancements in marine biology have helped us discover the animals that fit the requirements of the chilazon. Chemistry has brought us to understand the molecular nature of the dye that could be the color hue so we can analyze which liquid meets the specifications of the color. This just goes to show how beautifully Torah and science can go hand in hand, and how we can use scientific knowledge to better understand mitzvot. group of the intellectually weak. One should bemoan their foolishness; for they think that they are honoring and elevating the Sages, but in fact they are degrading them with the ultimate degradation, yet they do not realize this" [1].

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## Halacha meets DNA fingerprinting

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The genetic code is stored within the sequences of nitrogenous bases (i.e., adenine, thymine, cytosine, and guanine) on DNA of nuclear chromosomes and on mitochondrial DNA. Except for isolated mutations, an individual's DNA remains constant throughout life and forms that person's unique genetic code, controlling biochemical reactions, growth, and development. About 99.9% of the human DNA sequences are similar in every person, with only a very small amount of DNA differing from individual to individual. These relatively minor differences serve as genetic markers and are of sufficient quantity to allow forensic scientists to distinguish one person from another person. Genetic markers, the DNA sequences used to identify (i.e., to mark) a specific location on a chromosome, include single nucleotide polymorphisms (SNPs) and copy number variants (CNVs). A SNP is a single base pair that differs among individuals. For a SNP to be a genetic marker it must be present in at least 1% of the population, thereby excluding those genetic variants that are too rare for general usefulness in genetic analyses. There are millions of SNPs in the human genome. Consecutive SNPs on the same DNA sequence of a chromosome are correlated, as each arose in history as a single point mutation which then was transmitted, surrounded by earlier SNPs, to descendants. Such a cluster of SNPs, when located near enough to each other on a chromosome, are transmitted as a unit (or, a haplotype). CNVs are tandemly repeated DNA sequences, present in different numbers of copies in different individuals. CNVs can range in size from one a kilobase, a thousand base pairs, to a megabase, a million base pairs. CNVs vary in number from person to person. A genetic marker is identified by a probe, usually a short fragment of DNA that is a few or a few dozen nucleotides in length. Both the genetic marker and the probe are made single-stranded, with the genetic marker detected by pairing (termed, hybridization) between the complementary base sequences on the genetic marker and on the probe [1, 2].

The technique of DNA fingerprinting is as follows. DNA is obtained either from blood, a root hair follicle, a buccal swab, or (in cases of rape) semen. Once isolated and purified, the DNA is cut with restriction enzymes, thereby generating thousands of DNA fragments which are placed into wells of an agarose gel for electrophoresis. An electrical field is applied and the DNA fragments (which carry a negative charge) migrate towards the positive electrode, with the smaller sized fragments moving faster than the larger sized fragments. This process is termed DNA gel electrophoresis. The double-stranded DNA fragments, now separated according to their sizes, are transferred from the gel (which can easily break) to a nitrocellulose or nylon filter; the double-stranded DNA fragments then are denatured to single-stranded DNA fragments. This transfer process is termed Southern blotting. Specific DNA sequences are identified by their interactions

with radioactive single-stranded DNA probes. Those DNA probes that are complementary to sequences in specific DNA fragments hybridize on the filter; the excess, nonhybridized probes are washed away. The filter is exposed to X-ray film and those fragments of DNA that have bound the probes appear as dark bands on the film. The developed film, called an autoradiogram, shows the pattern of a DNA profile. To eliminate the chance of mistaken identity, forensic scientists use several different probes. Although more than one individual might have a particular DNA fragment, it becomes less likely that multiple individuals will have several sequences in common. The multiplication rule is applied, in which the chance of two independent events happening simultaneously is their product [1, 2]. For example, suppose that the chance of having fragment #1 is 5%, of fragment #2 is 10%, of fragment #3 is 5%, and of fragment #4 is 10%. The chance of having fragments #1 through #4 is  $0.05 \times 0.1 \times 0.05 \times 0.1 = 0.000025$  (0.0025% or 1 in 40,000). In actuality, many more probes are used, so that the likelihood that the DNA profile of one individual would be an exact match to that of someone else is so remote that it is virtually nil. As a DNA fingerprint pattern could only fit one person out of myriads of people, a specific DNA fingerprint pattern falls under the halachic category of *umdenah demuchach*, or a totally obvious and logical assumption which is so overwhelmingly apparent that we accept it as fact [3]. Rav Zalman Nechemia Goldberg, halachic authority and Chief Justice of the Rabbinical Court in Jerusalem, noted that the chance of error regarding DNA evidence ranges from a billion to one to a quintillion to one, putting it in the category of a *siman muvhok* for victim identification [4].

DNA fingerprinting is applied in identifying humans, animals, and plants.

(a) Humans. Identification of cadavers and human remains and fragments, after natural catastrophes, military actions, and terrorist attacks, is essential for the completion and certification of legal documents, such as death certificates and wills, and for the distribution of benefits and insurance claims. Victim identification is also important regarding the remarriage of the surviving spouse. According to halacha, a Jewish woman who is presumed to be a widow cannot remarry unless she has definitive proof of the death of her "missing" husband. Without such proof, should she remarry, this latter association would be considered adultery and any child from that relationship would be designated as a *mamzer*, a person born to certain relationships forbidden by halacha. Mere presumption of the death of her husband is insufficient in halacha to allow the woman, now termed an *agunah* (or, chained woman), to remarry. Also, in halacha, a man is not permitted to be simultaneously married to two sisters. To allow a presumed widower to marry the sister of his deceased wife, mere presumption of the death of his wife is insufficient [5]. DNA fingerprinting,

performed on the DNA removed from a disfigured cadaver or from human remains, may provide the evidence needed to change the presumption of death to the certainty of death, since “currently the chance of error in a properly administered DNA test is greater than 10 billion to one” [6].

In Israel in the 1990s, Muslim terrorists carried out numerous suicidal bombings in crowded public places, including on buses and in a pizza store, creating a forensic nightmare in identification of human remains and fragments. Halacha requires immediate burial, as such, victim identification and reconstruction of the human remains into a complete body for burial needed to be accomplished as soon as possible. In instances of suicidal bombings, body parts were scattered throughout the area, making reconstruction of the body a complicated process. DNA fingerprinting was applied to the identification of these human remains, thereby allowing for the piecing together of the body fragments into a complete human body. Victim identification was carried out by the Division of Identification and Forensic Science of the Israel National Police Headquarters in Jerusalem, which developed laboratory protocols whereby the extraction of DNA from cadaveric fragments was accomplished in one hour, followed by DNA amplification by the polymerase chain reaction (PCR) method, and subsequent DNA typing within 2 hours, thereby yielding results in 2 to 3 hours. DNA technology, coupled with visual recognition, fingerprint analyses, and dental data, allowed for identification of 86% of the cadavers within 24 hours [7].

Forensic science technology, which included the usage of DNA fingerprinting, was employed to identify the human remains after the September 11, 2001 Muslim terrorist attacks on the Twin Towers, World Trade Center in Manhattan. As with the suicidal bombings in Israel, many of the bodies of the victims were never recovered intact, leaving married women in doubt of their marital status, both as a widow and as an agunah. Rav Yonah Reiss, RIETS, then recently assigned the director of the Beth Din of America, assumed the main role in assisting these presumed widows. A working relationship was established between the Beth Din of America and the NYC Medical Examiner’s Office, the unit charged with identifying body fragments. Rav Reiss and his colleagues developed expertise in DNA analyses and concluded that DNA fingerprinting was a powerful tool in victim identification [8]. The NYC Medical Examiner’s Office tested the DNA from body parts found near the World Trade Center and compared them with the DNA from personal belongings of the missing people, which were brought in by relatives. The laboratories tested 13 different genetic markers in each DNA sample that was received. The odds of a DNA sample belonging to someone else other than to the matching sample was less than one in a trillion, or fewer than all the people who have ever lived. Such data were sufficient for the dayanim of the Beth Din, Rav Gedalia Dov Schwartz and Rav Mordechai Willig, to permit these presumed widows to remarry, and thereby to leave the category of agunot. Whereas DNA evidence was considered sufficient for victim identification regarding 9/11, some American and Israeli rabbinical courts prefer to couple DNA evidence with other data (e.g., dental records) [8, 9].

The Medical Examiner’s Office is located on First Avenue and East 26th Street, near the NYU Medical Center and relatively close

to Stern College for Women. In an empty lot adjacent to the East River were a dozen refrigerated trucks, loaded with body parts of the victims of the 9/11 attack. Jewish volunteers, including many undergraduates from SCW, came to take part in the around-the-clock recitations of Tehillim. Shifts were established and this shmira watch ran without stop for 24 hr/day, seven days/week, from September 11, 2001 until April 30, 2002 [10]. “But on Shabbat, when the volunteers - who came from as far as New Jersey and Pennsylvania - couldn’t take trains or taxis to reach the site, students from Yeshiva University’s Stern College for Women, which was within walking distance of the morgue at 30th Street and First Avenue, managed the vigil” [11].

In addition to using DNA fingerprinting in victim identification, DNA fingerprinting has other important uses in the court system, most often to establish paternity in custody and child support litigation. Parentage testing cases are numerically the largest users of DNA testing. Most paternity testing is done for financial reasons, i.e., to establish legal responsibility and provide for financial support [1]. DNA fingerprinting has the potential to ascertain the potential mamzeirut status of an offspring, i.e., that the husband was not the biological father of the child. Rav Ovadia Yosef regarded DNA evidence of parentage as inadmissible proof in *beit din*. Also, Rav Yosef Shalom Eliashiv avoided using DNA evidence to reveal the identity of a mamzer, although he apparently believed that DNA evidence was admissible in *beit din* [12]. Rav Shmuel Ha’Levi Wosner and Rav Nissim Karlitz, *poskim* of Bnei Brak, ruled that DNA fingerprinting analyses do not constitute evidence for mamzeirut status, but do have relevance for allowing an agunah to remarry [6]. The approach of the rabbinical courts, apparently, is that there is no obligation to be proactive to reveal the mamzeirut status of an individual.

No technique is 100% perfect and, apparently, there is at least one instance in which DNA fingerprinting may provide misleading data. Consider the case of Lydia Fairchild, a pregnant mother of three who applied for public assistance. DNA analyses for paternity tests unexpectedly showed that she was not the biological mother of her three children. Taken to court and accused of fraud, the court appointed a witness to be present at the birth of her fourth child. DNA analyses of Fairchild’s blood, skin, hair, and saliva did not match with that of her newborn. The initial thought was that, perhaps, she was a surrogate mother. Her attorneys requested additional DNA analyses. DNA taken from her cervix, however, did match the DNA of her four children. Lydia Fairchild was a tetragametic chimera, formed in utero by the fusion of two zygotes or of early stage embryos (which should have developed into fraternal twins), containing two genetically distinct cell lines. Thus, Lydia was two females in one, with each cell line forming distinct organs of her body. The cell line that eventually produced her ovaries and, apparently, other organs of her reproductive tract was a genetic match to her four children. The other cell line, which apparently formed her blood, hair, skin, and salivary glands, upon DNA analyses did not match the DNA of her children [13]. Such cases of tetragametic chimeras are rare and, as they can be handled successfully by forensic DNA laboratories, should not be an impediment for halachic issues of victim identification.

(b) Animals. The same technology used to fingerprint human beings

is applicable to identifying animals. As cattle were disappearing from Israeli farms, Bactochem, an Israeli company, developed a database of cattle DNA to be used to identify each animal in case of theft. The database provided sufficient evidence to build a court case against the thieves, who were mainly Bedouins. An outgrowth of this DNA technology is being considered for kashrus issues. A cattle processor would send meat samples from each slaughtered animal to Bactochem, who would then generate a DNA fingerprint profile for that specific animal. The DNA profile would be encoded on a barcode, attached to each package of meat that the processor produced for that animal. If the meat was further cut or repackaged at a supermarket or at a warehouse, a copy of the barcode would be attached to each package. When a customer wanted information about the meat picked from the store refrigerator, a photo of the barcode would be uploaded on a smartphone developed by Bactochem. Data about this particular cow would be at the fingertips of the customer [14]. Rav Moshe Tendler, RIETS and Biology Department, Yeshiva College, suggested that DNA fingerprinting could be applied to spot check fish to ensure that they are of a kosher variety. This potentially could be used in place of sending kosher supervisors to foreign countries, thereby saving unnecessary monetary expenses [15]. DNA fingerprinting could also alleviate the concern of whether dolphins were inadvertently processed along with tuna fish.

Around 2010 it was becoming more and more apparent that parasitic marine worms, or nematodes, were noted in the flesh of wild salmon, thus triggering concern that consumption of such fish impacted on hilchos toloyim. Soon after, worms were noted in canned sardines. This halachic issue is most complicated and ignited much debate among rabbinic authorities; attention will focus only on the aspect of this debate that is relevant to DNA fingerprinting. Parasitic worms associated with fish are not a new halachic issue, as the Talmud (Chullin 67b) noted cases of fish infested with worms. An interesting conversation was recorded between Ravina and his mother. Apparently, Ravina observed worms in the fish being prepared by his mother. Repulsed by the worms, he requested that his mother mix the worms with the fish and then he would consume it. A factor in the permissibility of consuming fish infested with parasitic worms is the location of the worms. The Shulchan Aruch (Yoreh Deah 84:16) notes that worms identified in the internal organs (e.g., stomach and intestines) of a fish are prohibited to consume, whereas worms found within the flesh or between the skin and the flesh are permitted for consumption.

The marine parasitic worm noted in the flesh of salmon was, *Anisakis*, a nematode with an interesting and complex life cycle. Adult worms mate within the stomach of a host mammal (e.g., dolphin, seal, whale, etc.) and produce unembryonated eggs which are excreted from the host's intestines into the aquatic environment. The eggs settle to the ocean floor, embryonate, and develop into free-swimming larvae. These larvae are ingested by crustaceans (such as, krill, a type of shrimp), and mature within their host. The crustacean is then consumed by a predator fish, which, in turn, is consumed by larger fish, such as salmon, remaining viable in the latter's digestive tract. Upon death of the host fish, the larvae migrate from the intestines and penetrate and then encyst within muscle tissue. These encysted *Anisakis* ignited the issue of hilchos toloyim regarding their occurrence in salmon, halibut, sea bass,

scrod, and sardines. The life cycle of this worm is continued within the mammalian host (which, possibly could include a human being who had eaten sushi). Within the mammal, the encysted larvae emerge as adult worms, mate, and produce eggs, which are released with the excreta of the mammal into the marine environment [16, 17].

Initially, when evaluating the life history of *Anisakis*, there was some confusion as to whether the worm noted in the digestive tract was capable of boring through the intestines of the host fish to encyst within its musculature. Perhaps, the encysted worm within the flesh was not the same worm identified in the intestines. Rav J. David Bleich [17] suggested that DNA fingerprinting of the free larva and of the encysted larva would solve this dilemma. Subsequently, parasitic worms were noted to be contaminating canned sardines. "The presence of worms portends of improper handling during which intestinal contents have been allowed to commingle with sardine meat ... in a manner that would compromise kosher certification. Fish can harbor nematode life history stages in musculature and elsewhere besides the intestinal lumen; the difference in tissue location is predicated on the nematode species in question and its life cycle." The OU commissioned Dr. Mark Siddall, a parasitologist at the American Museum of Natural History, to perform DNA analyses of worms observed in canned sardines. The research clearly showed that the worms in the canned sardines were species of *Anisakis* and were the type noted in muscle tissue, thereby permitting the sardines for consumption [18, 19].

(c) Plants. DNA fingerprinting analyses on botanical species have focused on the esrog (*Citrus medica*), as there were concerns of its purity, particularly, whether it was grafted to a lemon tree. Grafting of a tree branch from one species to that of another species is forbidden. The Mishnah listed forbidden grafts among fruit trees (Kilayim 1:4), without reference to an esrog which can be grafted only to a lemon tree. This lack of recognition in the Talmud of grafting an esrog branch to a lemon tree was because in the era of the Talmud, the lemon tree was not, as yet, indigenous, to the Middle East. Lemon trees were introduced into the Middle East from the 7th century and onwards [7]. Thereby explaining the lack of Talmudic literature on an esrog-lemon hybrid.

Today, however, there are concerns of a hybrid esrog-lemon. Nicolosi et al. [20] obtained esrogim with differing phenotypes, from different environments, and conducted DNA fingerprint analyses on them. The esrogim included those from Israel (5 varieties), Italy (2 varieties), Morocco (2 seedless varieties), and Yemen (3 varieties of extremely large fruits). The results showed no introgression of lemon or other citrus genomes into the genomes of the esrogim that were analyzed. However, Rav Yechiel Stern [21] consulted with botanical experts and concluded that even the kosher esrogim have some genetic traces of the lemon genome. However, cross pollination, not grafting, was the cause of concern. Apparently, bees transporting pollen from stamens of flowers from lemon trees cross-pollinated pistils of flowers on esrogim trees. However, no scientific data were presented. In addition, it is difficult to understand why only traces of lemon genome were noted in these esrogim. If the lemon genome was introduced by cross pollination to an esrog, then 50% of the resultant fruit would be esrog DNA and 50% would be lemon DNA.

This brief discussion focused on DNA fingerprinting. However, other advances in DNA technology have provided the means to improve the quality of life. For example, most Orthodox Jewish young adults understand the need for DNA analyses in premarital genetic screening for genetic diseases. Tay-Sachs disease, primarily because of Dor Yeshorim's genetic screening program, has been eradicated among Orthodox Jewry. DNA technology also plays a key role in assisted reproductive technology regarding preimplantation genetic diagnoses (PGD) of preembryos for genetic diseases, as well as for gender selection. Although rabbinical authorities frown upon preembryo gender selection for frivolous reasons, an interesting case was reported in which it was permitted. The potential father was a kohen who did not produce sperm. The couple received rabbinic permission to use donor sperm and to

use PGD to specifically select female preembryos for implantation. Producing a female, rather than a male, child would eliminate the question of the kohen status of the child, which would arise when the boy is called for an aliyah to the Torah [15]. Recently, the complete genetic sequence of Ashkenazi Jews was deciphered. These data will serve to better understand genetic diseases and as a vehicle for developing personalized medicines [22]. Beyond the scope of this article are the halachic issues raised by creating genetically-engineered foods, both plant and animal [23-26].

This increased knowledge has provided human beings to partner with HaShem in perfecting the world, as noted in Bereshis (1:28), humanity is required "to fill the world and conquer it."

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