Derech HaTeva

A Journal of Torah and Science

Volume 15, 2010 - 2011 תשע"א

A Publication of Yeshiva University
Stern College for Women

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Volume 15 2010 - 2011

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PRINTING: Advanced Copy Center
Brooklyn, NY 11230

DEDICATION & ACKNOWLEDGEMENTS

DEDICATION

We dedicate the fifteenth volume of Derech HaTeva: A Journal of Torah and Science to the memory of the five members of the Fogel family from Itamar, Israel who were brutally murdered by terrorists while sleeping in their home on leil shabbat March 11, 2011. Rabbi Ehud (36), Ruth (35), and their three children Yoav (11), Elad (4) and Hadas (3 months) were prematurely and ruthlessly taken from us that Friday night and were survived by children Tamar (12), Roi (6), and Yishai (2). The Fogel family was expelled from their home in Gush Katif only a few years prior to moving to the West Bank community of Itamar where Rabbi Ehud taught at a hesder yeshiva. His wife Ruth was also known as a wonderful teacher who was very dedicated to serving her community, and most importantly, committed to raising her children.

We present this volume of Derech HaTeva in the Fogel family's honor and memory. L'ilui Nishmatam, may their memory be a blessing.

ACKNOWLEDGEMENTS

We would like to extend our sincere gratitude to Dr. Harvey Babich. Without him, Derech HaTeva 5771 would not have made it to print. His perpetual dedication to each and every student and his enthusiasm for the pursuit of higher Torah and scientific knowledge were the driving force behind this publication.

The Editors

Ilana Ickow Elisa Karp Leora Perlow

PASUK

כי חיים הם למצאיהם ולכל בשרו מרפא

משלי ד׳:כ״ב

For [the words of Torah] are life to the one who finds them, a cure for his whole body.

Proverbs 4:22

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MAN'S PLACE IN BRCA

Pamela Apfel

The theological debate of whether medical practice intervenes with G-d's divine plan is a centuries-old debate, and the questions still linger. To what extent can man treat or cure illness without violating G-d's intended plan? Is it possible that G-d intended for someone to remain ill and therefore any treatment would be a violation of G-d's word? Or did G-d intend for man to intervene in His affairs and cure the sick? At what point is it considered that man is playing the role of G-d instead of acting as His partner in creation? In the Midrash Shmuel, there is a story about Rabbi Ishmael and Rabbi Akiva that illustrates the concept that G-d relies upon man to aid in the process of healing [1].

It happened that Rabbi Ishmael and Rabbi Akiva were strolling in the streets of Jerusalem with another man. They encountered a sick person who said to them, "My Masters, tell me with what should I be healed?" They told him: "Take such-and such until you are cured". The person who was with them said to them: "Who afflicted this man with sickness"? They said: "The Holy-One-blessed-be-He." He said to them: "And you interfered in an area which is not yours! He afflicted and you heal?" They said to him: "What is your occupation?" He said to them: "I am a farmer, as you can see by the sickle in my hands." They said to him: "Who created the field and the vineyard?" He said: "The Holy-One-blessed-be-He." They said to him: "And you interfered in an area not yours? He created these and you eat their fruit?" He said: "Don't you see the sickle in my hand? If I did not go out and plow the field, cover it, fertilize it, and weed it, nothing would grow!" They said to him : "Fool…Just as with a tree, if it is not fertilized, plowed, and weeded, it does not grow, and if it already grew but then is not watered, it dies; so with regard to the body. Drugs and medicaments are the fertilizer, and the physician is the farmer" (Midrash Shmuel 4:1) [1].

If it is so that man can and should aid in the healing process, to what extent may he do so, specifically in regards to treating breast cancer?

Dr. Z. Wahrman, in her book entitled Brave New Judaism explains the genetic blueprint of all individuals. All humans alike are built by their unique genetic DNA code, constructed with four chemical building blocks, simplified as the letters A, C, G and T. When one letter or sequence of letters is "deleted" or "out of order," a gene mutation is created, affecting one's genetic makeup as a whole. Specifically, the genes associated with breast cancer are known as BRCA1 and BRCA2. When functioning properly, they prevent and suppress uncontrolled cell growth; however, when mutated, a cell whose growth should otherwise be suppressed may grow uncontrollably and become cancerous. There are three

With the advance of genetic screening, does the biblical obligation to guard health include genetic testing for the potentially fatal BRCA gene?

predominant gene mutations in the BRCA genes, two in BRCA1 and one in BRCA2. The genetic mutations in BRCA1 are designated "185delAG" and "5382insC". In "185delAG," the letters A and G are missing in the 185th position on the BRCA1 gene [2]. In "5382insC," the base C was inserted at the 5382 position on the BRCA1 gene [3]. The mutation found in the BRCA2 gene is known as "6174delT," indicating that the letter T is missing in the 6174 position [2].

The risks for developing breast cancer vary among different populations. Specifically, Jews of Ashkenazi descent may be at a greater risk for developing breast and ovarian cancers than the general population [4]. According to Ari Mosenkis [3], the "185delAG" mutation is present in 1% of Ashkenazi Jewish women, the "5382insC" mutation in 0.1% of Ashkenazi Jewish women, and the "6174delT" mutation in 0.9-1.5% of Ashkenazi Jewish women. Thus, the total estimated carrier frequency for breast and ovarian cancers in Ashkenazi Jewish women is around 2%, in striking contrast to the 0.1% of the general population [2]. Finally, within the Ashkenazi Jewish female population that has mutant forms of BRCA, the estimated risk of breast cancer is 56% by the age of 70, which is four times that of non-carriers. Additionally, for BRCA positive women with family histories of

the disease, their estimated risk of breast cancer is even higher, with an estimated 85% risk by age 70 [3].

Wahrman notes, "It is important to understand that inherited breast cancer genes probably cause no more than 10% percent of all breast cancers" [2]. Furthermore, it is not certain that a woman with a mutated BRCA gene will develop cancer; rather it means that the woman is at higher risk for developing the pathology [1, 3, 5]. Wahrman interestingly mentions that scientists found that BRCA1 and BRCA2 act like recessive genes; both copies of either gene must be mutated, which is extremely rare, in order for cancer to develop [2]. While this should indicate that cancer is a rare event since both copies of the gene would have to be mutated, it is known all too well that cancer is not a rare occurrence. This is due to the infrequent and unsystematic possibility that genes have the capacity to mutate on their own. Thus, if a woman has already inherited one faulty copy of the gene from one parent, all it takes is one random mutation in the BRCA gene for cancer to develop. As a result of potential random mutation of genes, as well as the influences of the environment, lifestyle, hormonal factors, and other inherited traits, even women without mutant BRCA are at an approximately 11.1% risk for developing breast cancer by age 80 [2].

How does BRCA fit into Torah and halacha? There is a statute in the Torah, in Deuteronomy 4:15, which states that a Jew must guard his soul – "*vinishmartem miod linafshoteychem*." Traditionally, this verse is understood to mean that one must guard his health. According to Rabbi Dorff [1], there are two principles behind the Jewish approach to health and medical care. Firstly, the body belongs to G-d. Secondly, people have permission and an obligation to heal [1]. In regards to the former, because an individual's body belongs to G-d and not to the individual, the individual has a duty to maintain his body as best as possible. Our bodies are on loan to us by G-d from the time that we are born until the time that we die, similar to the loan of an apartment, like Dorff mentions. In the duration that the apartment is on loan, sufficient care must be taken in preserving it. One cannot treat it recklessly for it is not his or hers. So too, with our bodies – when our bodies are on loan to us during our lifetime, we must take care of them and preserve them, be it through seeing a doctor when sick, proper hygiene, exercise, sleep, etc. [1]. When we die, our bodies are returned to G-d, hopefully in the same pristine and pure condition in which they were given. The question therefore arises that when man maintains possession of his body during his lifetime, to what extent may he treat his body without playing G-d?

The extent to which the statute to guard health applies is extremely controversial due to the concern that one may come to "play G-d." Moreover, the strides that have been made in medicine and genetics—for example, genetic screening, genetic engineering, and genetic therapy—make this question even more troublesome and inconclusive. With the advance of genetic screening, does the biblical obligation to guard health include genetic testing for the potentially fatal BRCA gene? Should mass screenings of the Ashkenazi Jewish female population be instated, for perhaps, not screening constitutes a danger to life, *sakanat nefashot*? Or, is the risk of causing mental anguish enough to make genetic testing not obligatory? If a woman is tested positive for the BRCA gene, must she disclose this information to a potential suitor? If a fetus is found to have a mutant BRCA gene, indicating that it has a higher risk for cancer, may the fetus be aborted? And finally when gene therapy becomes available to humans, will it be permissible to fix the mutated gene before cancer occurs? On taking such proactive steps, Rabbi Dorff asks, "Is it proper to tamper with the genetic destiny by fixing the germ line...? At what point do we "cease legitimately to be G-d's partners in creation and become instead G-d's substitute, "playing G-d," as it were, in changing the nature of species? [1]"

The answers to these questions are not absolute; one must always consult with his rabbinical leader. However, one thing is clear, as states Rabbi Dorff, "…human medical research and practice are not violations of G-d's prerogatives but, on the contrary, constitute some of the ways in which we fulfill our obligations to be G-d's partners in the ongoing act of creation" [1]. By pursuing medical research and treating patients, man is in fact fulfilling his obligation to join with G-d in continuing creation. Thus, it is appropriate to deduce that methods performed to cure disease at its root, perhaps by changing an individual's "genetic destiny," through genetic engineering, would be permissible [1, 2]. For example, Dorff sanctions that when gene therapy becomes available to repair cancer genes, Jews will be obligated to use those treatments before the cancer develops. He explains that the same way that man's duty to prevent illness applies to disease caused by bacteria, viruses, or environmental causes, so too, the duty applies to diseases caused by faulty genes [1].

The question of mass genetic screening for BRCA now comes to the forefront. Should the entire Ashkenazi Jewish population be tested for this potentially fatal gene? Mosenkis mentions the possibility that "mass screening for BRCA may actually be halachikally obligated, as not screening may constitute a potential danger to life, or *sakanat nefashot* [3]. Karen Rothenberg, J.D, M.P.A., lists the benefits and risks of predictive testing. While the

benefits are medical benefits, the risks are not; they are of a different nature – a social and psychological nature [6]. She notes the following benefits: "Test results will relieve uncertainty; promote early detection, surveillance, prevention, and intervention strategies; enable us to better plan for the future; influence reproductive decision-making; and give us information to share with blood relatives, particularly children, so that they can better assess their risk for cancer" [6]. Mosenkis focuses on two other main benefits- the potential to preserve health and the alleviation of mental anguish, whether a positive or negative test result is achieved [3].

In contrast to the medical benefits, the risks of mass genetic screening are of a different nature. Rothenberg continues, "… genetic information will increase anxiety; change self-image; alter family relationships; create social and group stigma; impact on privacy and confidentiality, and result in both insurance and employment discrimination" [6]. In addition to the psychological risks, Mosenkis states that mass genetic screening has the potential to yield false positives, resulting in unnecessary worry, as well as "complacency when there should be vigilance" [3]. Moreover, medical benefits such as mammography are not even one hundred percent reliable [3]. Finally, Rabbi Moshe D. Tendler, Rosh HaYeshiva of Rabbi Isaac Elchanan Theological Seminary, discourages mass screening for two reasons. Firstly, it may lead to discrimination and stigmatization, specifically from potential mates [3]. And secondly, genetic testing for BRCA is an issue of "tyranny of knowledge;" knowledge of one's BRCA status will bring about anxiety and mental anguish because there is no definitive cure [4]. Dr. Daniel Eisenberg, Department of Radiology of Albert Einstein Medical College, Philadelphia and a professor of Jewish Medical Ethics, has said, "We generally approach knowledge as a liberating force. Knowledge is power. Knowledge makes us the master of our fate. But sometimes knowledge becomes the master and makes us the servants...when information causes anxiety but offers no way to reduce that anxiety, it controls us" [4]. For the aforementioned reasons, it is clear that mass predictive testing may not be a definite method to pursue; perhaps only the at-risk groups should be screened. The question is, however: who is the at-risk population? Is it the general Ashkenazi Jewish population? Is it just women with a family history of breast cancer? Are men included in the at-risk population? How strong of a family history warrants genetic screening?

Mosenkis writes that some secular medical authorities advised that only women with strong family histories of breast cancer, i.e., three or more family members diagnosed before the age of fifty, be screened for BRCA. Similarly, some national cancer organizations advise that screening should only be done for women who have already been diagnosed with breast cancer, to help them decide between more aggressive or more conservative therapies or for research purposes. In identifying the at-risk population to be tested, a very important question is whether carrying a BRCA mutation is considered *sakanat nefashot* – a potential danger to life - and if so, then screening could be obligatory [3]. Dorff believes that the at-risk population has a positive obligation to undergo genetic screening based on two principles [1]. First, if the woman tests positive for the BRCA mutation, she will grow more accustomed to check herself regularly, as well as to maintain the recommended mammogram scans. Second, the woman will be open to the option of a mastectomy; although it is not guaranteed to prevent breast cancer from developing, it will reduce the woman's risk by a considerable amount [1, 3, 4]. According to a recent study, thirty-year-old women who carry the BRCA mutation and undergo prophylactic mastectomy gained an average of three to five years of life [3].

We generally approach knowledge as a liberating force. Knowledge is power. Knowledge makes us the master of our fate. But sometimes knowledge becomes the master and makes us the servants... when information causes anxiety but offers no way to reduce that anxiety, it controls us.

In regard to aborting a baby with the BRCA mutation, Dorff states that it is clear that an abortion would not be sanctioned, for numerous reasons. First, carrying the BRCA mutation does not guarantee that cancer will develop, rather it signifies that the individual has a higher risk for cancer than the individual without the mutation. Second, the age at which cancer may develop in the individual carrying the BRCA mutation varies from person to person; an individual may only develop cancer at the age of 70, in which case she has lived the majority of her life as a healthy individual. Third, it is possible that by the time the fetus would reach the age for increased risk of developing cancer, more effective treatments or even possibly a cure will have been developed [1].

When considering the obligation or permission to test for a mutated BRCA gene, a practical question emerges – the ques-

tion of confidentiality. In relation to potential mates, it can be a very sensitive subject. In Judaism, much value is placed on truth and honesty; however there are also times where one is obligated to withhold the truth. In terms of telling potential mates, Rabbi Dorff believes that the woman would in fact be obligated to disclose her medical information to her potential suitor. Firstly, it is only fair for her potential husband to know that she is at a higher risk for breast cancer than the general population; he must enter the marriage with informed consent. Secondly, the woman must tell her potential husband because this BRCA mutation could influence the age at which they decide to conceive for the threat of developing cancer may require her to have children early in their marriage and surely her husband must have a part in that decision [1]. Next, the author of Sefer Chasidim, Rabbi Judah the Pious, rules that potential spouses must reveal to each other any physical defects and if they do not, then their marriage is void. In a similar vein, the Chofetz Chaim, rules that disclosure of medical information by a third party that may impact the suitor's decision to marry does not constitute the *issur deorayta* of tale bearing. Therefore, Dr. Avraham S. Avraham of the Nishmat Avraham, asserts that a parent is obligated to reveal medical information to a child's potential suitor. It is interesting to note however, that Dr. Avraham rules that a third party is in fact not obligated to reveal such information, although it is permitted. In addition to informing potential suitors, Rabbi J. David Bleich holds that potential employers be notified of any illness that may come into conflict with the employee's work. It is unclear whether a BRCA mutation is included in this category, however one may be able to argue that it is. Thus, there may be an obligation for the BRCA carrier or the BRCA carrier's parents to disclose such information to potential employers or insurance agencies if that knowledge may impact their decision to hire them or act as their insurance agent [3]. Nevertheless, one should always seek out rabbinical leadership.

The halachik issues surrounding BRCA span and affect a number of relationships - not only between man and G-d, but also between man and man and between man and himself. However, the primary questions that emerge within each context differ greatly: is the act of genetic testing a false assumption of the role of G-d? Can knowing the result of a genetic test be detrimental to one's psychological health and therefore not permitted? Can that knowledge impact a family dynamic, or terminate an impending marriage? The concerns involved in genetic testing touches upon everything from the esoteric to the painfully tangible. Short of closing this article with a non-committal assertion that the topic of genetic testing is exceedingly challenging and ever-so-complex, there is a key, albeit implicit reality that is woven throughout the topic's exploration – and indeed, influences any choice made in this arena. ■

ACKNOWLEDGEMENTS

I would like to publicly extend my warmest gratitude to my parents, Sheila and Ronny Apfel, for their constant support of my studies and for providing me with so much love and devotion throughout my life. I would also like to thank Dr. Babich for encouraging me to write this article, for providing the articles that enabled me to pursue this project, for taking the time to review the science content, and for assisting me in the pursuit of my career. Finally, I'd like to thank my sister-in-law, Yakira Apfel, for editing my work and helping me to explore this complex area of halacha and science.

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A WRINKLE IN PARENTHOOD

Rebecca Benhaghnazar

"Now Abraham and Sarah were old, well on in years; the manner of women had ceased to be with Sarah. And Sarah laughed at herself saying, 'After I have withered shall I again have delicate skin?'" (Genesis 18:11-12). Due to her advanced age, Sarah our matriarch, considered conception to be as great a miracle as the resurrection of the dead, which could only be accomplished by G-d. According to some commentaries, such as Radak and Sforno, she was postmenopausal. The Midrashic interpretation claimed that her menstrual cycle resumed after many years, telling of her ability to give birth; she thought this was a random occurrence, not a miracle, otherwise she would not have laughed. (Rashi). Sure enough, G-d granted her a child, as the verse says, "And Sarah conceived and bore a son to Abraham in his old age, at the time of which God had spoken to him" (Genesis 21:2). According to the Ma'am Loez her menstrual cycle resumed allowing her to conceive. It seems that Sarah experienced backtracking; she had already been through menopause, but her period resumed allowing her to conceive.

Postmenopausal bleeding has a plethora of potential causes, including hormonal imbalance, nutrition and insulin resistance, weight loss, emotional stress; such bleeding could even be an indication of endometrial cancer. But none of the preceding are indications of what Sarah must have experienced as her menstrual tract resumed after years of menopause. There are instances of women who do not undergo menopause until later in life and surprisingly conceive at older ages. The oldest recorded natural mother, a British woman by name of Dawn Brooke, gave birth to her son in August of 1997 at the age of 59. She had not yet experienced menopause and naturally conceived [1]. There have been no recorded instances of women who experience such backtracking like Sarah experienced.

It is important to note that the Rabbi Levi ben Gershon, a Bible commentator, physicist, and physician of the 13th century, more commonly known as Ralbag, offered an alternative explanation. As opposed to other commentaries that focus on Sarah's age and postmenopausal status, Ralbag explained that Sarah and Rachel's infertility stemmed from their unhealthy medical condition of obesity. Their husbands acquired concubines, and the wives lost weight out of their jealousy. Through weight loss, Sarah and Rachel were consequently able to become fertile and conceive [2]. Ralbag's explanation is reminiscent of the modern Polycystic Ovary Syndrome, more commonly known as PCOS, a female endocrine disorder which is a cause of subfertlity with obesity as a primary element [3].

> This backtracking that Sarah experienced defies the laws of nature. Such an event of backtracking has not been recorded in the history of medicine; it is a miracle unfathomable to the human mind.

Sarah is not the only biblical personality to conceive at an older age. Rabbi Elie Munk cited Rashi who stated that Yocheved was 130 years of age when she gave birth to Moshe. Ibn Ezra noted that the text does not indicate the miracle of Yocheved's conceiving Moshe even though Yocheved was quite elderly at that time. Ramban responds that Yocheved had already given birth to Miriam and Aharon before Moshe and there was no indication that she had been through menopause, as was the case with Sarah [4].

Yitzchack's name, which was commanded by Hashem to Abraham, is indicative of the great marvel of his conception. Yitzchack stems from the word Schock, meaning laughter. Rav Shimshon Rafael Hirsch explains that this name is significant as by all the laws of nature the concept of his birth was "laughable." As noted by Rabbi Nosson Scherman in the Stone Chumash, "The manner in which it happened that a woman who was infertile in her youth had a child at the age of ninety established the miraculous nature of God's chosen people. G-d could just as easily have given a child to Sarah in her prime, but that would not have been perceived as demonstrating Divine intervention" [5].

There is no unanimous consensus for the cause of Sarah's infertility. From the Ralbag's interpretation, which suggests that

Sarah suffered from PCOS, Sarah, similarly to Rachel, was barren as a result of her obesity. As a result of participating in a polygamous marriage, Sarah lost weight out of jealousy; therefore, Sarah was able to become fertile and conceive, resulting in Yitzchack's birth. Ralbag's account teaches the importance of maintaining a healthy lifestyle. On the contrary, the Radak, Sforno, Rashi, and the Ma'am Loez agree that Sarah was post-menopausal, and miraculously at the age of ninety she received her period, enabling her to conceive and give birth to Yitzchack. This backtracking that Sarah experienced defies the laws of nature. Such an event of backtracking has not been recorded in the history of medicine; it is a miracle unfathomable to the human mind. Sarah becoming impregnated at the age of ninety, after years of menopause, and a history of infertility, is evidently a medical miracle conveying God's glory with His ability to perform on the supernatural level. ■

ACKNOWLEDGEMENTS

I would like to express my sincere gratitude to my parents for supporting me in all my endeavors. Additionally, I would like to thank Dr. Babich for his encouragement and for providing sources for this article. Finally, I would like to express my appreciation to Rabbi Pilichowski for reviewing this article.

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AGING AND LONGEVITY IN SCIENCE AND TANACH

Rachel Blinick

How long do you want to live? In recent years there has been an increase in research on the causes of aging and how to prolong life. New suggestions of how to stay healthy and increase your lifespan are constantly recommended. We are advised to exercise frequently, eat right, not smoke, have a glass of wine a day, eat antioxidants, and a whole host of other suggestions that have been recommended in the last few years. Recent studies, though, have shown that what really makes all the difference is genetics. To quote an expert on aging, Steven Austad, "if you want to live to be a healthy eighty year old, you have to eat right and exercise, *et cetera*. If you want to live to be a healthy hundred year old, you have to have the right parents"[1].

Why do people age? One of the largely accepted causes is the reactive oxygen species (ROS) that are produced during aerobic cellular respiration. Small levels of ROS are necessary for cell function, but large amounts are believed to be harmful and eventually cause macromolecular damage that disturbs the homeostasis of the cell and leads to aging [2]. This seems to hold true for humans, but not for all animal species, which causes some doubt about this theory [1].

In recent years several causes of aging, such as environmental and epigenetic reasons, have been suggested, but one of the most highly researched topics of aging today is genetics. In the 1930's, it was discovered that restricting the diet of laboratory animals allowed them to live longer. This restricted diet inhibited tumor development and many other chronic diseases and also allowed the animals to be more active, and preserved their intellectual functions [1]. When researchers realized that the diet had such a profound impact, they looked at the various nutrient-sensing pathways, such as the kinase target of rapamycin (TOR), sirtuins, and insulin/insulin growth factor (IGF) signaling pathways. We know today that genes regulate part of the aging process through such nutrient receptor signaling pathways and transcription factors. Genes that increase lifespan are stress response genes or nutrient sensors that regulate gene function, kinase TOR or insulin. When there is an abundance of food and little stress, these genes support pathways that cause organisms to grow and reproduce. When there is a lack of food, the genes cause the organism to channel its resources into maintenance and repair. This shift protects the organism and lengthens its lifespan, so that it can reproduce when conditions improve [2].

We know that dietary restriction that inhibits insulin/IGF signaling is connected to longevity, therefore, diets high in glucose, that raise insulin/IGF signaling, probably shorten lifespan. The same applies to TOR kinase, a nutrient sensor that stimulates growth in the presence of high levels of food. When nutrients are present, they stimulate growth by upregulating the translation of certain genes. When diet is restricted in many animals, TOR kinase is inhibited, thereby increasing lifespan [2]. It is important to note that diet restriction studies have not been performed on humans because of the will power needed for such a task, in addition to the risks that stem from anorexia. Diet restriction to such an extent is counterproductive and causes damage to various organs and to the entire body [1].

Perhaps biological perfection implies that these earlier generations possessed some of the "mutations" found in centarians which contributed to their extended lifespan.

Studies on a nematode *Caenorhabditis elegans*, an organism commonly used in the study of aging, identified a mutation that decreased the level of a hormone receptor similar to that for insulin, which more than doubled its lifespan. Furthermore, these mutant organisms looked and acted younger much after the wild type (normal) worms aged [2].

In studies of centarians, or hundred year old people, it is apparent that a long life was a family trait, since most had siblings that age and had parents that died at that age. These centarians had various mutations, which varied among different groups. A group of Ashkenazi Jewish centarians expressed a mutation that affected the IGF receptor, while a Japanese group of centarians

had mutations in the insulin receptor. Variants in the FOXO3A gene have also been linked to longevity in different ethnicities, including Ashkenazi Jews. Genetic mutations that postponed aging also delayed age-related diseases [2].

Aging increases the risks of developing cancer, heart disease, and diabetes. People who live to be a hundred years or more are not immune to these diseases; they just acquire them later in life, or the diseases progress at a slower rate. The age at which the body begins to deteriorate is the factor that is genetically determined [1].

An interesting case study for examining the theological roots of aging would be the generations that lived from Adam until Abraham. According to the Talmud (*Avodah Zarah* 5a), Adam was created as an immortal creature. When Adam and Eve sinned by eating from the tree, they were told by G-d that they would eventually die, meaning that their biological clocks were set and their bodies would lose immortality [3]. Additionally, Adam and Eve were expelled from the Garden of Eden, thereby exposing them to all the non-genetic causes of death, such as accidents and diseases [4]. Still, Adam and Eve and the generations after them lived very long lives.

One of the reasons offered by Josephus as to their longevity was their diet. Maimonides, (the Rambam) believed that the longevity described in Genesis was a result of their diet and lifestyle, but he maintained that it was unique to those generations and was not found again [3]. The viewpoint that their diet was an important aspect is fascinating, in the light of the importance of the newly discovered nutrient receptors as factors in facilitating aging.

This view of the Rambam was challenged by the Ramban, Nahmanides, who believed that the generations who lived after Adam lived long lives because of their biological perfection, which was adversely effected by the flood in the days of Noah [3]. This Ramban is interesting because considering what we know about the role of genetics in aging, perhaps biological perfection implies that these earlier generations possessed some of the "mutations" found in centarians which contributed to their extended lifespan.

One suggestion as to how the flood adversely affected lifespan was that it caused the replication of microfungi, which produced highly toxic mycotoxins that affected the longevity of people after the flood. Mycotoxins are responsible for various diseases and disorders, including cancers and other diseases involving gene mutations. Molds have always existed, but only produce their mycotoxins in suitable conditions such as high humidity. The flood provided conditions suitable for the growth of mycofungi, which when airborne, polluted the air inhaled as well as contaminating foods and drinks. The adverse health effects caused by mycotoxins would have impacted not only those who lived through the flood, but the generations thereafter, hence shortening the lifespan of their descendents [5].

An alternative explanation brought down by the *Midrash Bereshis Rabbah* (26:5) was that when Adam's biological clock was set, he still lived a long life, and this trait was inherited by his children. This trait was maintained because those descendants married amongst themselves. In the days of Noah, "The sons of G-d (Adam's descendants) saw the daughters of man (other people alive at the time) and they were fair and they took for themselves wives from all whom they chose" (Genesis 6:2). Adam's descendants intermarried which resulted in reduction of their children's lifespan [3]. After Adam's descendants, the average lifespan steadily declined throughout the generations. In the twenty first century though, we have seen the average lifespan increasing in developed countries.

In recent years, hygiene and living conditions have improved, as well as the invention of new methods to preserve food and limit the growth of molds, thereby improving the health and lifespan of people [5]. According to Jewish sources, longevity is one of the aspects of the Messianic Age. According to the Talmud (*Sanhedrin* 99a), the era preceding the Messianic Age will not be a time of miracles or of changes in nature, but rather, as implied by the Rambam, it will be a time of technological and scientific advancements that we have witnessed in the past century with improvements in health care and life in general [3].

Aging is a complex process that involves many factors and the more we know about aging, the more we may be able to maintain our health. Both the Rambam and the Ramban realized that there was an aspect of diet and "biological perfection" in longevity, which we know today are both important aspects. As science continues to investigate genetics, we can still do our part and eat healthy, exercise, and take care of ourselves properly. ■

ACKNOWLEDGEMENTS

I would like to thank Dr. Babich for his encouragement and help in writing and editing this article. I would also like to extend a thank you to Rabbi Aaron Cohen, Rabbi of Tifereth Israel of Passaic, NJ for editing the Torah content of this article. Additionally, I would like to thank my parents for their constant support and encouragement in my education. Finally, I would like to extend my thanks to my friends and the editors for reviewing my article.

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DREAMS: REALITY OR FANTASY?

Sarit Cohen

"A dream that is not interpreted is like a letter that is not read" (*Berachot* 55a). The Torah conveys to us that dreams are Divine communications and prophecies similar to the dreams of Yoseph and of Pharaoh. As we can see in Numbers 12:6: "If there be a prophet among you…I will speak to him in a dream." Furthering this idea, the Talmud tells us that dreams foreshadow the future. The Midrash (*Bereshit Rabbah* 68:12) tells us that no dream is without interpretation. Yet, the Talmud also states that dreams have no meaning and no importance (*Sanhedrin* 30a) and in *Tanach* it states that "dreams speak falsehood" (*Zechariah* 10:2) [1]. Do our dreams hold any importance? Should we try to interpret them? Should we even pay any attention to them? What exactly do our dreams mean and where do they come from?

We spend six years of our life in dreams. For centuries, scientists have been trying to understand the nature of dreams and their meaning. Sigmund Freud claimed that all details of a dream have significance. The feelings you experience in a dream are those that were pushed out of your consciousness during the day and are only expressed at night during our dreams. His theory stated that dreams are for transferring our subconscious to our consciousness. Unconscious drives and desires that would be threatening if expressed directly are thus expressed through dreams. Instinctive desires and experiences occur in a dream, while during waking hours, logic rules [2]. Thousands of years earlier, our Torah had told us the same thing. A dream is a "strong desire which is unfulfilled" (*Yishayahu* 29:8).

Other psychoanalysts suggested that the purpose of dreams is to transfer temporarily stored memories into long term storage. Dreams help sift, sort and fix the day's experiences into our memory. Psychoanalysts believe that the storage of memory in our brain is effectuated through stories and parables. Dreams are revelations of disorganized thoughts which are suppressed during the day and revealed at night during sleep. Most rabbinic commentators believe that dreams originate from the imaginative recesses of the soul. Dreams come from ideas and impressions one already knows, or from thoughts and expressions one has perceived throughout the day [4]. In *Berachot* 55b, Rabbi Yonatan stated: "a man is shown in a dream only what is suggested by his own thoughts" [3]. Our dreams come from our own memories, experiences and thoughts. According to the Abarbanel, these dreams have no meaning and one should pay no attention to them. The Rabbis also tell us that even though the thoughts and ideas in a dream are in part correct, there is still useless information in the dream [4]. The psychoanalytical theory which stated that our dreams sort out our memories and experiences seems to complement our early rabbinic sources.

Centuries earlier we see the Talmud speaking of something quite similar to what we know of as the self- fulfilling prophecy.

Before we start paying attention to our dreams, we must delve into the notion of self-fulfilling prophecy. "The self-fulfilling prophecy is, in the beginning, a false definition of the situation evoking a new behavior which makes the original false conception come 'true'." It is a prediction which causes itself to become true, by influencing people's beliefs and behaviors [5]. The Thomas Theorem states: "If men define situations as real, they are real in their consequences." Once people convince themselves that a certain perception has true meaning, they will take very real actions according to this false perception [6]. This causes our perceptions or dreams to become reality by our very own actions, not by the "truth" of the perception or dream. The perception has no truth in and of itself, but holds truth to the viewer and will thus cause him to behave in a certain way, thus leading to the fulfillment of the false perception or dream. Centuries earlier, our tradition has portrayed to us this same idea. The Talmud tells us that a fulfillment of a dream depends on the suggestion of the interpreter. The way that you define and perceive your dream may affect its fulfillment. In *Berachot* 55b, the students of Rabbi Eleazer interpreted a dream for a woman by explaining that her husband would die. Rabbi Eleazer chastised his students and told

them that they have caused a man to die. Centuries earlier we see the Talmud speaking of something quite similar to what we know of as the self- fulfilling prophecy. If a person perceives his dream as true, he will now act in a certain way that he would not have done otherwise, thereby causing the dream or prophecy to come true [3].

We can now see how many various opinions there are regarding the importance of dreams. Many books have been written attempting to interpret dreams and relate their significance. The Talmud and *Tanach* both tell us that dreams have no significance whatsoever; while other rabbinic sources indicate that they do have meaning for the future. Our rabbis considered some dreams to have real significance, as seen from the laws of voiding a bad dream and fasting for a bad dream. Some assert that dreams are only partially true. This is based on *Berachot* 55a which stated: "there cannot be a dream without some nonsense". Some Kabbalists hold that a whole dream is not fulfilled, only part of a dream is. These various opinions on dreams try to determine the significance of dreams of ordinary people since the dreams of prophets mentioned in *Tanach* clearly have meaning and significance. Our Rabbis taught that a very small percentage of dreams may be teachings from heaven, if the person's soul is very strong and healthy. A dream whose contents deals with danger to a life, we take to heart. If a dream does not deal with *halacha* and does not contradict Jewish law, one should pay attention to this dream. If a dream points to trouble for the world, one should try to nullify it with fasting. However, most dreams are questionable in validity and therefore hold no authority in matters of *halacha*. Most rabbis wrote that one should not accept the authority of a dream at all since *halacha* is "not in heaven" and because dreams "speak falsehood" (*Zechariya* 10:2) [4]. We can see that while our Rabbis have decided to take the road of caution when one's dream represents danger, most of our sources indicate that dreams hold no real importance as *Iyov* tells us: dreams are "something fleeting which rapidly evaporates" (Iyov 20:8). ■

ACKNOWLEDGEMENTS

I would like to thank my incredible parents for constantly supporting me throughout my educational career and for constantly encouraging me to pursue my goals. I would also like to express my gratitude to my brother, Rabbi Ariel Cohen, for reviewing this article. And finally, I would like to thank Dr. Babich for his continual support and guidance.

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ANIMAL EXPERIMENTATION: A HALACHIC PERSPECTIVE

Batya Edelman

Animal testing has always been a controversial subject. There are valid arguments for both the use and termination of animal testing. In response to such arguments, many government agencies have passed laws that permit animal testing while simultaneously protecting the animal's rights and preventing animal abuse. Rabbinic literature addresses the question of animal testing, that will be further explored in this article.

Animals have been used to enhance the study of science for centuries and are used today for a variety of reasons. The earliest sources of animal experimentation are Greek documents that included descriptions of animal dissections. Since then, humans have used animals to learn more about themselves and the world around them. Animals' physiological similarities to humans allow them to be used in studies of human behavior, diseases, and development. There are many ways in which animals are used in research, but the broader categories include pure research, applied research, toxicology, drug testing, xenotransplantation, and breeding. In pure research, scientists use animals to study the development, function, and behavior of humans as well as to further general scientific knowledge. Applied research refers to research conducted to answer a specific question. This would include any study conducted to find the source or cure for a disease. Toxicology testing is performed to determine if a drug is toxic or carcinogenic before it is put on the market. Drug testing, similarly, is used to determine the efficacy of drugs before they are sold to the public. Xenotransplantation involves the transplantation of live tissue into a different species. This allows scientists to experiment on human tissue without affecting a real person. Experimentation using animal breeding generally deals with evolution and genetics [1-4].

Rabbinic leaders also look to address the issue of animal testing. Many sources in the Torah and in halacha would lead one to believe that animal testing is prohibited. *Shemot* 23:5 notes that one should help even the donkey of his enemy if it is suffering under a burden. A Jew must remove what encumbers a helpless animal even if it leads one to assist his enemy. Additionally, the Rambam explained that the reason behind the law of *shechitah* (kosher slaughter) is to reduce the pain of the animal as much as possible [5, 6]. *Shechitah* demands that the knife be sharpened without any notches to ensure that the animal undergoes as painless and quick a death as possible. Furthermore, *Devarim* 25:4 notes that one may not muzzle an ox while it plows a field. It is significant that the Torah takes into consideration the manner in which an owner treats his animal, as it would be cruel for an ox to plow a field of food without being able to eat from it [5]. Finally, the law of *tzaar baalei chayim* prohibits the causing of unnecessary pain to an animal. Animals subject to testing may feel pain and suffering, particularly if they are not cared for properly and are subject to cruel treatment [7]. These commandments demand that humans take responsibility for the well-being of animals by helping to eliminate unnecessary burdens, and by forbidding pain infliction upon an animal. Uncontrolled or thoughtless experimentation on animals involves inflicting undue harm on animals, which contradicts the spirit of these laws. If these mitzvot demand that people relieve animal stress, surely harmful experimentation on animals would be frowned upon. One application of this would be regarding toxicology testing. Toxicology testing may cause an animal to develop cancer, which would be painful to the animal and a potential violation of tzaar baalei chayim. The prohibition of causing pain to an animal is highlighted in the story of Balaam (*Bamidbar* 22:32-33) when the angel of Hashem reprimanded Balaam after he hit his donkey three times. Because Balaam was scolded for inflicting pain upon his donkey, it can be inferred that such an infliction of pain is forbidden [5].

> Hashem, Who is abundantly merciful and compassionate, created animals and continues to care for their needs. Likewise, Jews must strive to be merciful and compassionate and care for animals.

Many great leaders of *Bnei Yisroel* were shepherds who were sensitive to animals' needs. Moshe Rabbeinu was chosen to be the

leader of *Bnei Yisroel* only after he cared for a flock of animals. The Rabbis taught that when a kid from his flock fled, Moshe chased it. When the kid stopped to drink at a river, Moshe said, "I didn't realize that you were running because you were thirsty. Now you must be tired!" (Rabbi Cohen). He then carried the kid back to the flock. Hashem saw Moshe's compassion and only then declared him to be qualified to take the Jews out of Egypt. *Dovid Hamelech* was also a shepherd before becoming king of *Bnei Yisroel*. He showed signs of compassion and sensitivity by tending to the weak and helpless. Moshe and Dovid were great leaders of *Bnei Yisroel* because they possessed the qualities necessary to lead and care for the needs of the people [7].

The ideals of sensitivity and compassion are also necessary for the ordinary Jew. Jews are commanded to walk in the ways of Hashem. Hashem, Who is abundantly merciful and compassionate, created animals and continues to care for their needs. Likewise, Jews must strive to be merciful and compassionate and care for animals [5]. By tolerating animal testing, which inflicts pain upon animals, a person may become callous and insensitive. Proverbs 12:10 states: "The righteous one knows the needs of his animal's soul, but the mercies of the wicked are cruel." A righteous person cares for and understands the needs of his animal, while a wicked person is cruel and does the opposite [9]. Animal testing causes pain to an animal and could therefore be viewed as an act of the wicked [5, 7, 9].

While it is forbidden to needlessly cause pain to animals, there are many instances in which one is allowed to derive benefit from animals, and it is in such instances that animal testing is permitted. The simplest example of the permissibility of deriving benefit from animals is that man is allowed to kill animals for food. *Bereishit* 9:3 states: "Every moving thing that lives shall be food for you." Animals may be killed for a human to benefit from their meat. The Talmud (*Chullin* 85b) described a situation in which the killing of an animal is encouraged. Rabbi Hiyya had a pile of flax that became infested with worms. Rebbi advised him to slaughter a bird over a tub of water so that the worms would be attracted to the blood and leave the flax. In this manner, harming a bird helped Rabbi Hiyya monetarily. Therefore, even for monetary motivations one was permitted to cause pain to animals. This may be because the Rabbis considered animals as created for the use of humans. In *Shabbat* 77b, Rav declared that each of Hashem's creations has a purpose to benefit humans. He created a snail that helps heal a scab and a fly that serves as an antidote for a hornet's sting. Everything was created to benefit humans in some way. If so, animal testing must be permissible. The *Shulchan Aruch* noted that inflicting pain upon animals is permissible if such an act directly serves to medically assist humans. According to this logic, applied research is permissible to cure human diseases. Other types of research would also be allowed, as many of them strive to treat human illnesses or prevent harm. The author of *Shvut Yaakov* permitted the use of animal testing to determine the effect of medications [7]. Additionally, many Rabbis in the Talmud illustrated a thorough knowledge of animal anatomy, physiology, pathology and medicine in general. As noted in *Chullin* 57b, "The medical knowledge of the Talmudist was based upon tradition, the dissection of human bodies, observation of disease, and experiments upon animals" [10]. If these great Rabbis performed experiments on animals, then it seems that animal testing is permitted.

Halachic rulings give legitimacy to animal testing, but discourage one from causing more harm than necessary. Animal experimentation should only be carried out if there is a significant amount of knowledge or benefit that could be obtained, and no other trial methods are available. Animals subject to experimentation should be treated with care, with all their physical and psychological needs met, and with every attempt made to reduce pain and discomfort. To make the world a better place is a goal that every human should strive for, but to lose one's sense of humanity and compassion to attain a better world is worthless. ■

ACKNOWLEDGEMENTS

I would like to extend my gratitude to my parents for their support and encouragement to pursue my dreams. I would also like to thank Dr. Babich for his help in completing this article, and Rabbi Kelemer of the Young Israel of West Hempstead for reviewing the article for the halachic content.

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SMOKING: PERSONAL DISCRETION OR HALACHIC VIOLATION?

Esti Feder

"Be very careful to guard your soul" (Deuteronomy 4:15). This *pasuk* in the Torah has classically been used by *rabbanim* throughout Jewish history to promote preserving one's health through proper diet and exercise [1]. However, one wonders if this *pasuk* pertains only to proactive, health-promoting actions such as daily exercise and proper nutrition. Does the *halachic* commandment to preserve health also apply to refraining from hazardous behaviors such as smoking?

Although smoking was once advocated as salutary, in modern times there is no longer any doubt that cigarette smoking is a danger to one's health. An overwhelming amount of medical evidence has proven that cigarette smoking is associated with adverse health effects and a shortened life expectancy [2]. Statistics have shown that damaged health due to smoking account for an estimated 443,000 deaths per year, or nearly 1 in every 5 deaths. The myriad negative effects of smoking include damage to the cardiovascular and respiratory systems, cancer, and decreased fertility in women [3].

For example, smoking reduces circulation by narrowing the blood vessels. This can lead to coronary heart disease, peripheral vascular disease (obstruction of large arteries in the arms and legs), or abdominal aortic aneurysm (a swelling or weakening of the main artery of the body, the aorta, where it runs through the abdomen). In the respiratory system, smoking causes lung cancer, bronchitis, emphysema, and chronic airway obstruction. Smoking is also the major cause of many different types of cancers, including cancer of the esophagus, larynx, pharynx, and oral cavity. An increased risk of cancer can cause infertility in women and puts pregnant women at a risk for preterm delivery and stillbirths. Babies born to smokers often have low birth weights and an increased risk of sudden infant death syndrome. Smoking also increases the risk of stroke. Clearly, smoking harms nearly every organ of the body and can increase the risk of or even cause many different diseases [3].

Despite all of these devastating health affects, many people are still addicted to smoking and cannot stop this destructive behavior. Smoking is addictive due to the chemicals in the tobacco. The main drug component of tobacco is nicotine, a psychoactive drug with stimulant effects on the brain. Nicotine acts on the receptor in the brain usually used by the major neurotransmitter, acetylcholine, known as the nicotinic receptor. Acetylcholine is involved in arousal and reward, and it activates the "pleasure centers" of the brain, such as the mesolimbic dopamine system. Therefore, when nicotine acts on the acetylcholine receptor, it can reproduce the effects of acetylcholine on the body, leading to a sense of calmness [4].

The rabbanim concluded that smoking of cigarettes constituted a blatant violation of the Torah commandment against inflicting harm on oneself and therefore is prohibited according to halacha.

When smoke is inhaled, nicotine enters the blood stream through the lungs. When tobacco is chewed, the nicotine can enter the body through the lining of the mouth, known as the buccal mucosa. Smokers can develop a tolerance to nicotine, and therefore need to increase their doses in order to feel the same effects when they first began smoking. If a smoker tries to quit, nicotine withdrawal can cause a host of physiological and emotional symptoms. This is because after continual use of nicotine, the body produces more acetylcholine receptors in an attempt to restore the normal function of the body despite what it perceives as "extra acetylcholine". Therefore, when these "extra doses" are withdrawn, there are many uncomfortable physiological effects produced by the now-useless extra receptors. Some of the withdrawal symptoms include fatigue, insomnia, headaches, dry mouth, cravings to smoke, irritability, sore tongue and/or gums, and tightness in the chest. Although withdrawal symptoms are temporary, they can be very uncomfortable while they last and many people avoid quitting due to fear of withdrawal symptoms [4].

With all these statistics and facts in mind, it would seem clear

that smoking should be in violation of the dictum, "Be very careful to guard your soul" (Deuteronomy 4:15). However, the stance of the *rabbanim* on this issue of smoking and *halacha* is not so easily defined. Perhaps one of the most significant obstacles to a decision to prohibit smoking *halachically* was the stance of the late *Posek HaDor*, Rabbi Moshe Feinstein, *zt"l*. Rabbi Feinstein strongly urged people to stop smoking and discouraged non-smokers from developing the habit; however he was unwavering in his position that smoking cannot be banned based on *halachic* grounds. Rabbi Moshe Feinstein argued that, based on the principle of "*Shomer Psayim Hashem"*- G-d protects the simple - which states that even if a specific action possibly entails danger, if people are willing to take the risk then one cannot forbid people from that action (Psalms 116:6, *Shabbat* 129b and *Niddah* 45a) [5].

Rabbi Moshe Feinstein was not alone in his position; Rabbi J. David Bleich wrote an article in the 1970's about smoking in which he stated that smoking should not be prohibited by *halacha*. Just like Rabbi Feinstein, he explained that certain actions which contain an element of danger, such as crossing the street or riding in a car, are permissible because these dangers are accepted with equanimity by society at large. Therefore, a person who partakes in these activities can rely upon the dictum that "G-d protects the simple" (Psalms 116:6, *Shabbat* 129b and *Niddah* 45a) [2].

In contrast to Rabbi Moshe Feinstein, who avoided an outright prohibition of smoking, an earlier commentator had a different position. The *Chofetz Chaim,* Rabbi Israel Meir Kagan, *zt"l*, who died in 1933, categorically prohibited smoking, pointing out that it is harmful to both the body and the soul and thus causes one to neglect Torah study [2]. Many contemporary *rabbanim* have joined the *Chofetz Chaim* in his opinion, including Rav Shlomo Zalman Auerbach, *zt"l*, Rav Efraim Greenblatt, *shlita*, Rav Eliezer Waldenburg, *shlita*, Rav Avigdor Nebenzhal, *shlita*, and Rav Ovadia Yosef, *shlita.* All of the aforementioned *rabbanim* categorically came out with the opinion that smoking is against *halacha*. Many of the *rabbanim* explained that the dictum of "G-d protects the simple," invoked by Rabbi Moshe Feinstein in his *teshuva* about smoking, cannot apply to this situation. For example, Rav Eliezer Waldenburg explained that "G-d protects the simple" can only apply in a case where life experiences indicate that people are protected from the risks of a certain activity. However, as Rav Avigdor Nebenzahl stated, we can clearly see in our modern day that G-d is not protecting smokers [6]!

Many present-day *rabbanim* have also attempted to rebut the decision of Rabbi Moshe Feinstein, by claiming that with the irrefutable medical knowledge available to our generation today, the arguments set forth by Rabbi Feinstein are now no longer valid. In 2005 an article was published by the *rabbanim* of the Rabbinical Council of America, in which they brought Rabbi Moshe Feinstein's arguments under analysis, and stated that for the rule of "G-d protects the simple" to apply, two conditions must be present. Firstly, the activity must only present a possible danger to the individual, and secondly, most people must be willing to take the risk involved in pursuing the activity. The *rabbanim* argued that at the time that Rabbi Moshe Feinstein made his decision, both of those factors seemed to indicate that there was no basis to *halachically* ban smoking. However, in our day, the scientific evidence undoubtedly proves that smoking is not only a possible danger, but rather a definite danger. Additionally, in recent years, due to the large anti-smoking educational effort in America, many people have stopped smoking. This may change the *halachic* status of smoking to a risk that most people are not willing to chance. Therefore, since both of the conditions of Rabbi Moshe Feinstein's original response are no longer applicable, the *rabbanim* concluded that smoking of cigarettes constituted a blatant violation of the Torah commandment against inflicting harm on oneself and therefore is prohibited according to *halacha* [5].

Another article published in 2006 by the *Va'ad Halacha* of the RCA, chaired by Rabbi Asher Bush, concluded with the unequivocal ruling that smoking is clearly and unquestionably forbidden by *halacha.* One important opinion mentioned in the article was a statement made by Rabbi J. David Bleich, *shlita.* Rabbi Bleich said "it appears that the cumulative risks of lung cancer, cardiovascular disease and respiratory illness will, in the aggregate, foreshorten the lives of the majority of smokers. If the majority of smokers do indeed face premature death as a result of cigarette smoking there is, according to the *Binyan Tzion's* thesis, no *halachic* basis for sanctioning the practice even though the multitude continues 'to tread thereon.'" Rabbi Bleich further explained that Rabbi Moshe Feinstein was correct in his ruling on smoking based on the information available to him in his day. However, it is most likely that at present the conditions which led to his lenient ruling no longer apply [6].

In his article on "Cigarette Smoking and Jewish Law," Dr. Fred Rosner, past Chairman of the Medical Ethics Committee for the State of New York and professor of medicine, brought a statement from the Rambam's classic work *Mishneh Torah* to prove that smoking was a *halachic* prohibition. The Rambam enumerated a variety of prohibitions, all based upon the *pesukim* "take heed to thyself and take care of thy life" (Deuteronomy 4:9) and "be very careful to guard your soul" (Deuteronomy 4:15). Thus, Rambam

stated that many things are forbidden by the Sages because they are dangerous to life. He asserted that if one disregards prohibitions simply because he wants to put himself in danger or is not particular about such things, he must be punished. Based on this position of the Rambam, it seems obvious that placing one's health or life into possible danger is prohibited by *halacha*. Therefore, the smoking of cigarettes, which has been irrefutably shown to be a danger to one's life, should be prohibited [2]. Dr. Rosner brought further proof from the *pasuk,* "And make an atonement for him, for that he sinned regarding the soul" (Numbers 6:11), in which the nazarite is called a sinner because he deprived himself of wine. The Talmud quoted *Rabbi Elazar Hakapar* who derived from this *pasuk* that a man may not injure himself. *Rabbi Elazar Hakapar* continued that a person who damages his health by injuring himself is considered a sinner. Dr. Rosner extended this reasoning to include smoking, by claiming that one who intentionally endangers his health and life by smoking is transgressing the Jewish law of injuring oneself. Dr. Rosner went as far as to say that smoking may in fact constitute a slow form of suicide, which is absolutely prohibited by Jewish law based upon the *pasuk,* "and surely your blood, the blood of your lives, will I require" (Genesis 9:5) [2].

Rabbi Moshe Feinstein was correct in his ruling on smoking based on the information available to him in his day. However, it is most likely that at present the conditions which led to his lenient ruling no longer apply.

Another issue directly related to smoking, is secondhand smoke, which has a more definitive conclusion amongst the *poskim*. The statistics for secondhand smoke show that each year, primarily because of exposure to secondhand smoke, an estimated 3,000 nonsmoking Americans die of lung cancer, more than 46,000 die of heart disease, and 150,000 to 300,000 children younger than 18 months have lower respiratory tract infections. Secondhand smoke exposure can cause a variety of health problems including heart disease, lung cancer, acute respiratory infections, ear problems, sudden infant death syndrome, and more frequent and severe asthma attacks in children [7]. There is a *pasuk* in the Torah that states, "Forty shall you strike him, he shall not add" (Deuteronomy 25:3), which discusses about the number of strokes mandated upon a convicted criminal. If the administrator of the strokes exceeds the 40 strokes, he is himself liable for assault and thus the punishments mandated for that crime. It can be clearly seem from this *pasuk* that according to Torah law, it is forbidden for one individual to harm another, and that one transgresses a negative commandment if he does so. Therefore, in accordance with the scientific evidence that smoking can cause harm to others through secondhand smoke, smoking in the presence of non-smokers should be prohibited by *halacha* [5].

Rabbi Moshe Feinstein was of this opinion, asserting that if the exhaled smoke is harmful to others in close proximity to the smoker, the smoker is obligated to smoke in private or far removed from other people [2]. Rabbi Feinstein claimed that people harmed by the smoke of others would be empowered by *halacha* to sue for damages [5]. Rabbi Eliezer Waldenberg, a colleague of Rabbi Moshe Feinstein and Rav Ovadia Yosef, also categorically forbade smoking in public places [8]. An article published in 2005 in a Jewish Medical Ethics journal by the *rabbanim* of the RCA, therefore concluded that rabbinical leaders and communities were obligated by *halacha* to ban smoking at all functions, meetings, buildings and facilities under their jurisdiction, both to secure the observance of *halacha* and to protect the physical welfare of their members [5].

The different views of *poskim* on smoking and *halacha* are linked by a common theme. Whether or not smoking should be prohibited by *halacha*, all *rabbanim* agreed that smoking is dangerous to one's health and should be avoided. As Rabbi Bleich explained, "Rabbi's should use their extensive powers of moral persuasion to urge the eradication of this pernicious and damaging habit!" [2].

Interestingly, a study done in 2005 by a group of Israeli researchers suggested that Orthodox Jews have less of a craving for smoking on *Shabbat* than on any other workday. The researchers took a group of 20 Orthodox Jewish students, who are heavy smokers during the week (about 20 cigaretters per day), but who abstain completely from smoking on *Shabbat*, and analyzed their level of craving for smoke on *Shabbat* and on a regular workday when forced to abstain from smoking for the study purposes. The researchers noted that craving levels on *Shabbat*, when abstinence was habitual for the smokers, was very low in comparison to abstinence on a regular workday. These findings suggested that craving levels for the participants in the study were affected by habits, cues, and expectations more than by smoking deprivation. The researchers explained that the decline in craving may be

a result of other factors, such as that *Shabbat* is a day of rest and therefore not as stressful as a workday. Since smoking has been associated with stress, the reduction of craving on *Shabbat* could be as a result of the lowered stress level [9]. However, from the fact that a *halachic* smoking ban results in reduced cravings, one can infer that if smoking was always *halachically* prohibited, cravings would perhaps always be reduced.

The strong scientific evidence for the negative health effects of smoking leads many of today's contemporary *rabbanim* to adopt the position that smoking is prohibited *halachically*, not only in the public sphere, but on the individual basis as well [5]. Additionally, regardless of whether or not it is *halachically* prohibited, there is a strong consensus amongst the *poskim* that smoking should be avoided as it is a dangerous and harmful habit [2]. Lastly, in light of the study that suggests that the craving for smoking is connected to expectations for it, if a unified statement was released from *rabbinic* authorities prohibiting smoking, then cravings may be reduced overall. As the rabbanim of the *Va'ad Halacha* of the RCA stated in their article, "the fact that all Orthodox Jews refrain from smoking on *Shabbat* shows that for a faithful Jew, reverence for *halacha* and obedience to it are far stronger than any addiction to tobacco" [6]. Hopefully, the shift against smoking that has already begun in the Jewish community will continue towards complete abstinence in the future. ■

ACKNOWLEDGEMENTS

I would like to extend a sincere thank you to Dr. Babich for encouraging me to write this article and for his continual support and assistance throughout the process. Additionally, I would like to thank Rabbi Asher Bush, chairman of the Vaad Halacha of the RCA, for his guidance in writing this article and for reviewing the Torah content of this article. I would like to thank my friend Rivkah Rogawski, for her help in editing this article. Lastly, I would like to express my sincere thanks and appreciation to my parents for their unending support and encouragement throughout my educational career.

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BAD BREATH IN THE TALMUD

Shira Goldstein

It is common knowledge that the Talmud and halachic commentaries discuss a wide variety of different topics that cover almost all areas of study. We often underestimate, however, the extent of the Rabbis' knowledge in seemingly secular areas, such as mathematics, philosophy, and science. In reference to science, the Rabbis exhibited an extensive understanding of the way the world, and specifically our body, works. This deep understanding often shaped the halachic conclusions in the Talmud and helped form the commentators' interpretations of various texts. By taking a deeper look into the specific physiology involved in various halachic and midrashic discussions, one can glean a greater understanding of the implications of the debated topics.

In *Ketubot* (72b, 77a), the Talmudists discussed halitosis, more commonly known as bad breath. According to the Talmud, bad breath is considered a serious disability, in regard to spouses and priests. It was considered to be a ground for divorce and it disqualified a priest from carrying out his holy duties.

In a Jewish marriage, the husband gives his wife a *ketuba*, or marriage contract, that dictates the financial obligations of the husband to the wife in the case of divorce. If, however, after the wedding, the husband finds a major disability in his wife for which he was unaware previously, he may annul the marriage and forfeit the ketuba obligations. Bad breath is considered to be one of these major disabilities that can allow the husband to cancel the *ketuba*. In general, there are lesser grounds for a woman to unilaterally divorce her husband. Bad breath, however, is considered such a major detriment in the husband (along with boils and engaging in foul smelling professions, such as leather curing, copper work, and collecting dog dung), that a woman is entitled to seek divorce (*Ketubot* 77a). The sages discussed whether nasal malodor should be given the same legal stature as oral malodor. Later, the great Jewish scholar, Maimonides (Rambam 1138-1204; Spain), decided that both types of malodor should be considered legally equivalent (*Hilchot Ishut* 25:12) [1].

Nowadays, most cases of halitosis originate from the mouth itself (about 90%), and only in more unlikely cases (about 5-10%) from the nasal passages. In most cases the odor is caused by bacterial decay in the oral cavity. In its initial phase, glycoproteins may be deglycosylated by Gram positive bacteria, exposing the naked protein to proteolysis by enzymes secreted by Gram negative bacteria. The amino acids are then be further broken down, yielding foul-smelling molecules, such as hydrogen sulfide (from breakdown of cysteine), methyl mercaptan (from methionine), cadaverine (from lysine), indole, and skatole (from tryptophan). Current scientific thought believes the tongue to be the major source for bad breath. Postnasal drip, food debris, and sloughed off epithelial cells collect on the posterior area of the tongue dorsum, where they are subsequently decomposed by the large microbial population. Serious cases of gingivitis and periodontal disease may contribute to oral malodor. Dryness of the mouth, which increases significantly during fasting or sleeping, also contributes greatly to oral malodor. Contrary to popular belief, the stomach does not contribute to bad breath, except in rare circumstances [1, 2].

Bad breath is considered to be one of these major disabilities that can allow the husband to cancel the ketuba.

Another area in halachah that involves the mouth's physiology is the law to wait a given period of time between eating meat and milk. In the Talmud *Chulin* 105a, Mar Ukbah stated, "In this matter of waiting between meat and cheese, I am vinegar the son of wine, because if my father ate meat, he would not eat cheese for 24 hours. I, however, do not eat them at the same meal, but at the next meal, I will eat cheese." Our Rabbis used Mar Ukbah's statement to determine the time one must wait between eating meat and milk. Rabbeinu Tam (12th century, France) understood Mar Ukbah's statement to mean that one must only wait until the next meal, whenever that happens to be. According to Rabbeinu Tam, one who eats meat, must then recite the grace after meals, wash his hands and mouth, and can then eat cheese. Other Rabbis, however, like Rav Yoseph Kairo (16th century, Spain) quanti-

fied Mar Ukbah's statement with a requirement to wait six hours--the time it takes for the taste of meat to completely leave one's mouth. Rashi (eleventh century, France) explained the "taste of meat" as the coating of fat that remains in one's mouth and throat after eating meat. Rambam explained the "taste of meat" as the particles of meat that remain between one's teeth after eating [3].

The Rabbis' concern of the remainder of the "taste of meat" can be better understood when explored physiologically. Digestion of all foods begins in the oral cavity. The first step is a physical digestive step, called mastication, or chewing food into smaller pieces to increase the food's surface area and to allow for easier swallowing. Mastication is controlled by powerful muscles called the massester and temporalis that move the mandible, or lower jaw, against the upper, in a motion which can crush even the toughest foods. Mastication causes exocrine glands under the tongue and in the back of the mouth to secrete a watery substance called saliva. The saliva moistens the crushed foods and allows the tongue to compact the food into a small, easily swallowed ball, called a bolus. The saliva contains digestive enzymes, like salivary amylase, that begins chemical digestion of foods in the mouth. The salivary amylase is able to break down carbohydrates to simple sugars at a relatively fast rate, as the food's surface area is repeatedly increased by mastication. Almost no proteins or fats are digested in the mouth, with the exception of a small amount of fats broken down by lingual lipase, an enzyme secreted by Ebner's gland on the dorsal side of the tongue [4].

Rashi's concern of a layer of fat remaining in the mouth after eating meat is very likely, because little fat breakdown is accomplished in the mouth. Any fat residue in the mouth would remain in its lipid form until is eventually broken down by lingual lipase enzyme, well after one has finished eating. Rambam's concern involves the process of mastication. Despite the sophistication of our oral digestive systems, the small string like pieces that result when meat is chewed can often become stuck in one's teeth for many hours after a meal. Apparently during the waiting period the pieces of meat are decomposed, perhaps by bacteria in the oral cavity, to an extent where they are no longer considered meat according to the *halachah*.

Practically, we take into consideration both Rashi and Rambam's reasons for waiting between meat and milk. It is important to note, however, that the amount of time waited between meat and milk differs among Jews based on differences in traditions. Many other properties of the mouth are discussed throughout the Talmud and *Midrash*. The lubricating characteristic of saliva is mentioned in *Shemot Rabbah* (24:1), "If a man ate bread as it is, it would go down into his digestive tract and scratch him, but Hashem created a well in the throat which conducts the bread safely down." *Bamidbar Rabbah* (18:22) hinted to the oral digestion of carbohydrates, "the water of the mouth is sweet." This referred to the taste of the simple sugars that result from the breakdown of carbohydrates by enzymes (salivary amylase) in the saliva secreted by exocrine glands in the mouth. The Talmud (*Bava Batra* 126b; *Shabbat* 108b) noted the therapeutic treatment of applying spit to an eye infection. The medicinal properties of saliva may be related to lysozyme, an agent that prevents cell wall synthesis of bacteria, which leads to the osmotic lysis of bacterial cells. Another approach attributed the remedial properties of saliva to potassium sulfocyanide, present in highest concentrations in the saliva of a fasting person [5, 6].

Allusions to the physiological workings of the mouth permeate the Talmud and commentaries. Gaining insight into the intricacies of our physiological makeup helps us acquire a deeper understanding of *halacha* and Torah in general and enhances our appreciation of the miracle that our bodies are. ■

ACKNOWLEDGEMENTS

I would like to thank my parents for constantly motivating and inspiring me to strive higher in my pursuit of education, as well as my husband, Yochanan, for providing me with endless support and encouragement. Thank you Dr. Babich for your help with researching this topic.

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SHOULD PRECONCEPTION GENDER SELECTION BE ALLOWED?

Nathalie Hirsch

Modern science has enabled us to improve many things in the world. It has allowed humans to detect flaws before they become actual problems and to cure diseases very easily. Along with all great developments come negative side effects as well. For example, plastic surgery can either be used to save a burn victim or to erase wrinkles from a face. In both cases the same procedure is done, but for very different reasons. In recent years the line between what is necessary for scientific reasons and what is an elective choice has become unclear. A controversial issue both in the secular and Jewish world has been preconception gender selection. There are ethical and *halachic* problems with the idea of favoring one gender of a baby over another, as well as the means by which this is done.

There are three methods by which parents can choose the gender of their offspring. The first is to conceive naturally, then have a prenatal diagnosis. Through a sonogram the sex of the baby can be determined and aborted if it is the undesired sex. There are many ethical and *halachic* problems with this, but this is not the main focus of the heated debate.

The second manner of determining offspring gender is pre-implantation diagnosis (PGD) followed by a selective implantation based on sex. In this procedure, pre-embryos created through *in vitro* fertilization (IVF) in the laboratory are identified according to gender. Then only the selected gender pre-embryos are implanted into the mother's womb. The third method of selecting offspring gender is the technique of pre-fertilization separation of the sperm into X and Y spermatozoa. The desired spermatozoa are injected through intra-uterine insemination (IUI). This procedure is known as flow cytometry separation (FCS) [1].

Gender selection is a unique field in that it has both medical and non-medical benefits. Choosing offspring gender might be necessary in a case in which one of the parents is a carrier of a genetic disease linked to one of the sex chromosomes. In such a case, gender selection may reduce the risk of producing a child with this disease. Others want to select the gender of their child because of convenience or for cultural or religious reasons [2].

When looking at the *halachic* problems with the methods by which gender selection is carried out, the first issue that comes to mind is if this is a legitimate way to fulfill the mitzvah of *p'ru ur'vu*. When discussed among the commentaries they compare it to a case in the *Gemara* (*Chagigah* 15a), in which a woman is impregnated in a bathhouse (*nitara b'ambati*). If a man had emitted spermatozoa into the water, causing the woman to get pregnant, what would be his status regarding *p'ru ur'vu*? This is left as a question and many commentaries have attempted to answer the question. This is similar to PGD and IUI in that the impregnation was not done by natural means. Do these methods actually count as fulfilling the mitzvah? Some commentaries made a distinction between PGD and IUI and *nitara b'ambati* because the father is actually involved in these procedures by donating the sperm [2].

In recent years the line between what is necessary for scientific reasons and what is an elective choice has become unclear.

Rav Moshe Feinstein (*Iggerot Moshe, Even HaEzer* 2:18) posed the question of whether the *mitzvah* of *p'ru ur'vu* is action-based or whether it is result-based [2]. The *Minchat Chinuch* proved that the *mitzvah* was result-based as proven by the law that if a person bears children, but then the children die without bearing their own children, the *mitzvah* was not fulfilled. If the *mitzva* is result- based, there is no question that the father still fulfilled the *mitzvah* of *p'ru ur'vu* even if gender selection of the child was done and the egg was artificially inseminated. But if it is action-based, which is Rav Feinstein's opinion, then there is a question of whether the father fulfilled the *mitzvah* [2]. Some opinions maintain that since he contributed the sperm, he fulfilled the *mitzvah*. Other commentaries disagreed because since the action of conceiving a child was not done naturally, there was no fulfillment of the *mitzvah* [2].

The second significant *halachic* problem regarding IUI and IVF for gender selection is the issue of *hashchatat zerah*, the wasting of "seed." In both of these procedures, the sperm was to be taken from the male, which would normally be a violation of *hashchatat zerah*. Many commentaries maintained that such an act is permissible for IUI since it is for the purpose of producing a

child. Others disagreed and claimed that it was wasting seed, since sperm is emitted but was not completely used [2]. The majority of the commentaries that allow IUI and believe that it is not a violation of *hashchatat zerah* based their leniency on people who have difficulty bearing children. Accordingly, it seems that gender selection through this method would not be permissible according to *halacha* since it is considered a violation of *hashchatat zerah* in cases where people do not have problems with fertility. In regard to PGD, there are commentaries that hold that the destruction of a viable embryo is a violation of *hashchatat zerah* [2]. Other commentaries disagreed, since the pre-embryos are frozen after insemination for possible future pregnancies or if the first implantation fails, there is no additional violation of *hashchatat zerah* [2].

Setting the *halachic* views aside, a major concern of these methods and preselecting the gender of a baby is the ethics perspective. If parents are allowed and willing to choose the gender of their child, is it possible that the balance of the world, and even the Jewish community, would become skewed? The male to female ratio would no longer be 1:1 and even if it were shifted a little, it could cause major problems. There was a study done in Germany where people were asked what gender they would choose for their child and the result was practically a 1:1 ratio [2]. But according to many sources, this is not a study that can be trusted.

Another ethical issue, which is a concern of many people, is that gender selection creates a slippery slope in the way of creating a "perfect" child [3]. People would look at the genetic makeup and attempt at fixing all the flaws to create a model child. People would select the genes for the most athletic, intelligent, or beautiful child and then there would be no room for genetics to play its assigned role. People would start playing G-d. This would not only create more competition, but would create a huge gap between the people privileged enough to have been "genetically engineered" children and the people who are not. Genetically perfect people would have more of an advantage in the world than everyone else and this would cause chaos [3]. Genetic selection would also cause a lowering of genetic diversity, leading to diseases being more effective and harmful, because without diversity everyone will be affected in the exact same way [3].

In conclusion, it is clear that the ethics and the *halacha* of preconception gender selection have to be considered for each specific case individually. There is no right or wrong answer, but it is necessary to realize that allowing gender pre-selection could lead society down a road of trying to take over the role of G-d, something no one will ever be able to do. ■

ACKNOWLEDGEMENTS

I would like to thank my parents for sending me to Stern. For encouraging me everyday and inspiring me to pursue a career in science. I would like to thank Dr. Babich for helping me find information for this article as well as dedicating himself to better the Stern Biology Department.

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AN ELEMENTAL AND DENTAL VIEW OF JUDAIC LITERATURE

Ilana Ickow

Dentistry has been practiced for thousands of years. The ancient Chinese developed toothbrushes from boar bristles, and the Etruscans of ancient Italy carved false teeth from ivory. Remains of primitive humans have been discovered with indentations in their teeth, presumably caused by toothpicks and an early form of dental floss [1]. In addition to such evidence and secular historical reports, throughout the generations of the *Tanach*, Mishnah, and Talmud, until the *Rishonim* and *Acharonim*, Judaic literature has discussed dentistry and has given significant insight into its advancement through the ages.

In *Tanach*, the word "*shen*," "tooth," is cited 42 times. The first dental mention in the Torah refers to personal appearance and occurs in *Bereishis* (49:12), when *Yaakov* blessed *Yehuda*, "*u'liven shinayim m'chalav*." *Yaakov* wished nourishment and plenty upon *Yehuda* by blessing him with teeth whiter than milk. The Torah also mentions teeth in the context of the judicial system, while referring to financial compensation in the words, "*shen tachas shen*," "a tooth for a tooth" (*Shemos* 21:24, *Vayikra* 24:20). The physical reaction of teeth to food is described in *Yirmiyahu* (31:29), "*kol ha'adam ha'ochel haboser tikhena shinav*," "any person who eats sour grapes, his teeth are set on edge." Most references to teeth in *Tanach*, however, are metaphorical descriptions of force and command. For instance, in describing the downfall of the enemy, *Zecharia* said, "*v'hasirosi… v'shikutzav mibein shinav*," "I will remove… [abhorrence] from between his teeth" (*Zecharia* 9:7), and in *Eicha*, the wrath of the enemy is described as "*vayacharku shen*," "they gnash [their] teeth" (*Eicha* 2:16) [2].

Later references, including the Mishnah, along with its commentary in the Gemara and works of *Rishonim* and *Acharonim*, give more literal clues about dentistry and its development through time. The Mishnah proclaimed, "A gold tooth, *Rabbi Meir* permits [wearing outside on the Sabbath] and the Sages forbid" (*Shabbos* 6) [3]. Why did some Rabbis prohibit wearing a gold tooth outside on *Shabbos*? *Rashi* (*Shabbos* 65a) cited the opinion of his teachers who said that a person who wears a gold tooth in public may become *embarrassed* because a gold tooth clearly does not resemble the other teeth. Therefore the person might remove the tooth while not within an *eruv* and violate the prohibition of carrying [4]. The *Avnei Nezer* added an additional reason why gold teeth would embarrass a person: he noted that false teeth were very rare at that time and a person would not want to be seen with something so uncommon [5].

Rashi, however, disagreed with the reasoning of his teachers and stated that the person will eventually carry the tooth on *Shabbos* because he will be *proud* of the expensive prosthesis and will remove it to show it to others. The *Maharsha* offered support for *Rashi's* opinion: there is a *beraisa* which stated that *R' Yishmael* bought his niece a gold tooth to enhance her appearance. Clearly, gold teeth were valued as a cosmetic enhancement at that time. The *Ben Ish Chai* reconciled the disagreement between *Rashi* and his teachers by distinguishing between yellow gold and white gold. He viewed yellow gold as conspicuous and embarrassing, but stated that white gold was beautiful and a person was likely to remove and display a white gold tooth [4].

There is a beraisa which stated that R' Yishmael bought his niece a gold tooth to enhance her appearance. Clearly, gold teeth were valued as a cosmetic enhancement at that time.

The Mishnah continued to state that silver teeth were permitted to be worn outside on *Shabbos*. According to *Rashi's* teachers, silver teeth were not as noticeable as gold teeth and were not embarrassing; according to *Rashi*, silver teeth were not as expensive as gold teeth and were not worthy of display. From this *halachic* debate, we learn that dental prosthetics during the times of the Mishnah, Talmud and *Rishonim* were composed of several materials and even were removable. It is also interesting to note the emotions linked to the various restorative materials at different times: during the Talmudic era, gold teeth were valued, whereas *Rashi's* teachers viewed them as unsightly and embarrassing [4].

The *Gemara* is replete with references to methods used to treat various dental ailments. In *Kiddushin*, it stated, "While drilling (*lachtor*) the tooth, it falls out." "*Lachtor*" means to drill, indicating that dental drills were already being utilized in the time of the *Gemara* [3]. It is interesting to note that while drilling was discussed as early as the *Gemara* period, the use of modern drills is a relatively recent development. Drills are commonly used in dentistry to remove caries, or decay, from inside a tooth. Before drills were invented, dentists resorted to toothpicks or scissors to remove caries. In 1790, George Washington's dentist invented a drill that rotated through use of a pedal, and in 1838 a "hand-cranked" drill was patented. Drills that operate with motors were not used until the 1860's. Today, mechanical drills rotate up to 400,000 rpm and are used to very accurately and smoothly shape teeth for crowns and fillings, with minimal discomfort to the patient [6].

Rashi, however, did not translate "*lachtor*" as "to drill," but commented that "*lachtor*" suggested a method to 'cleanse the base of the tooth.' *Rashi* described a scaling method, a procedure analogous to one still used today to treat periodontal disease [7]. Periodontal disease involves infection of the periodontium, the tissues around the teeth below the gumline, and can lead to bone and tooth loss. It is generally caused by accumulation of bacteria-laden debris beneath the gumline, which eventually forms calculus, or tartar, when exposed to the natural minerals of the mouth. A scaling procedure utilizes vibrating hand instruments to clean debris from below the gums. Scaling is usually performed with a procedure called root planing, which smoothes the root of the tooth to remove irregularities which could likely become the location of future buildup of bacteria [8]. Even in the times of the *Gemara* similar procedures were performed, as it said in *Kidushin*, "Scraping is a means of cleaning the teeth" [9].

The *Gemara* provided even greater insight into ancient dentistry. It described the use of wood, in addition to gold and silver, to replace teeth. In *Shabbos* 6:8c of the *Talmud Yerushalmi*, a story of a woman revisiting a "*nagra*," a carpenter, to replace her tooth, was discussed [2]. Toothpicks were used to clean and align teeth (*Tosefta Shabbos* 5:1). In *Chullin* (16b) it stated, 'A reed should not be used for this purpose because it may injure the gums' [10]. In *D'mai*, a story is told of *Rabbi Shimon ben Cahana* and *Rabbi Elazar* walking together, when one asked the other, 'Bring me a twig from the hedge to pick my teeth' [11]. Extractions were also performed, but they were considered dangerous surgical procedures, as *Rav* warned his son not to have his tooth pulled (*Pesachim* 113a) [10].

The *Rambam* offered much information about dental ailments and remedies. He described a gold tooth placed "on top of a black or red one." A nonvital tooth becomes blackened when the dentin layer is discolored by degraded blood cells, and a tooth may appear red when the outermost layer of enamel remains healthy but the internal pulp decayed [3]. *Rav Ovadiah MiBartenura,* however, described teeth "with a changed appearance due to mold" [7]. Today we know that tooth decay, or dental caries, is a disease which affects vital teeth only. It is caused when bacteria, attracted to sugars on the teeth, ferment the carbohydrates into organic acids. The acids, formed on the outer surface of the tooth, or enamel, travel via tubules to the inner layers of the tooth, dentin and pulp. Using aniline dye, Dr. G.V. Black detected tubules with greatly enlarged diameters, as a result of bacteria traveling to the inner layers of the tooth [12].

In *Regimen of Health,* the *Rambam* listed several remedies for a toothache, among them cinnamon bark, coriander, vinegar, and raisins [10]. The oral health benefits of raisins have been scientifically proven just recently, centuries after the *Rambam* suggested raisins as a cure for toothaches! Dr. C.D. Wu at the College of Dentistry of the University of Illinois researched the possible contribution of raisins to oral health. By utilizing antimicrobial assay-guided fractionation and purification technique, compounds in raisins such as oleanolic aldehyde, linolenic acid, betulinic acid, and beta-sitosterol glucoside were found to prevent the growth of oral pathogens. These antimicrobial phytochemicals inhibited bacteria which cause caries and periodontitis. In addition, the proanthocyanidins in grape seed extract were found to aid in the reduction of root caries [13].

The importance of oral health to the general health of the body has been known for centuries, as the *Yalkut Shimoni* described, "The health of the body depends on the teeth" [9]. However, recent scientific studies are beginning to prove more conclusively the link between oral health and general health. Drs. Kaneko, Yoshihara, and Miyazaki found a positive correlation between the number of sites of root caries and C-reactive protein serum levels. Higher levels of this protein indicated an elevated risk of cardiac dysrhythmia and cardiovascular disease [14]. In addition, a study on Pima Indians with diabetes concluded that periodontal disease caused an increase in the number of diabetic complications due to increased blood sugar levels. When the periodontal disease was controlled, the diabetic complications decreased markedly [15].

The advances in dentistry today would not have been possible without building on the knowledge and achievements of previous

generations. One particularly interesting modern development in dentistry is the use of dental stem cells to regenerate lost tooth and bone structure. Dental pulp stem cells, or DPSCs, are capable of renewal and differentiation, and studies have shown that DPSCs can form dentin, pulp, bone tissue, and crown structures [16].

In addition to DPSCs, other types of dental stems cells have been researched. Drs. Park, Jeon, and Choung obtained DPSCs, periodontal ligament stem cells (PDLSCs) and periapical follicular stem cells (PAFSCs) from molars of beagle dogs and allowed these cells to regenerate. PDLSCs were found to be the most effective in regenerating alveolar bone, cementum, nerves, blood vessels, and periodontal ligaments [17]. Mesenchymal stromal cells (MSCs) extracted from third molars were also utilized to derive stem cells. Through retroviral transduction of three transcription factors (OCT3/4, SOX2, KLF4), induced pluripotent stem cells, which were similar to human embryonic stem cells, were formed from MSCs [18]. Exfoliated deciduous teeth, or "baby teeth" may also prove to be a promising source of stem cells (SHEDs) which can regenerate tissues. Dental pulp was removed from deciduous teeth, and SHEDs were cultivated in cell culture medium. Analysis of these cells revealed that SHEDs did not degenerate in long-term experimentation [19]. Therefore, banking of exfoliated deciduous teeth may become popular in the future, as this method of storing a person's own stem cells would be an effective and painless way to eliminate risk of immune rejection [20].

From the timeless verses of the Torah, through the palpable conversations in the *Gemara* and analyses of the commentators, we have traced references to dentistry throughout our history. By learning how our ancestors related to this field and how it has changed, we can gain a new appreciation for the development of modern dentistry and the contributions of our religious sources to this science. ■

ACKNOWLEDGEMENTS

I would like to express heartfelt appreciation to my parents for your continuous support, for providing me with a superior education, and for being my role models through your constant acts of *chesed*. Thank you to Dr. Babich for all your help and guidance in writing this article and producing this volume of Derech HaTeva. Thank you for the many opportunities you have given me in Stern to learn, to give, and to grow. I will forever be inspired by your generosity, dedication, and concern for your students. Thank you to Rabbi Laibel Schapiro for editing this article for its Torah content.

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COLORFUL CHEMISTRY IN HALAKHA: THE MYSTERY OF TEKHELET

Elisa Karp

Color plays a prominent role in many aspects of Jewish law (*halakha*). The details of ritual observance often include a description of a distinguishing color, which separates clean from unclean, as in the laws of *negaim* and *niddah,* and mandate the required color of some ritual objects, such as *tefilin*. The chemistry of color change can be used as a tool in the observance of *halakha*. For example, modern scholars have been using color chemistry in their search for the lost *tekhelet*, the blue dye of one of the four strings on each corner of *tzitzit*.

An early example of the use of color chemistry in aid of *halakhic* observance was the preparation of ink for Torah scrolls. Iron gall ink was in popular use from the 12th century to the 19th century for Torah scrolls and other manuscripts because it was easy to make, it was permanent, and it adhered well to parchment. The galls, abnormal outgrowths of plant tissues caused by parasites, that were used to make the ink were obtained from oak trees and were crushed to yield gallotannic acid. When mixed with water, the ester links break and yield gallic acid. Gallic acid was then mixed with water and iron (II) sulfate, resulting in iron gall ink [1]. When it was first applied to the parchment, the ink was a light brown or sepia color, but as it dried it turned purplish-black. Over time, as the ink began to corrode, it oxidized, turning back to its brown-red color, and after a while the ink detached from the parchment [2]. This last color change was caused by the iron in the ink, which underwent an oxidation-reduction reaction when exposed to oxygen to form iron oxide, also known as rust, which imbued the ink with a reddish-brownish hue [3]. These color changes were crucial from the *halakhic* perspective: since the Torah scrolls must contain black ink, the sepia-colored ink which was first applied was invalid until it dried and turned black; similarly, when the ink began to oxidize and turn brown again, the scrolls were invalid [4].

Another important example of the use of color-related chemistry in the observance of *halakha* is the *ptil tekhelet*, the blue string on the *tzizit*. God commanded Moses, "Speak unto the children of Israel, and bid them that they make them throughout their generations fringes in the corners of their garments, and that they put with the fringe of each corner a thread of blue" (Numbers 15:38). Though there was once a detailed process to creating the *tekhelet* dye, this integral part of the *mitzva* of *tzitzit* was lost many centuries ago. The *gemara* in *Menachot* discussed *tekhelet*, indicating that the method of dyeing the *tekhelet* was available until at least the fifth century, but the method was lost in the middle of the Gaonic period, during the eighth century. Two specific components of the *tekhelet* process were lost: the method of dyeing of the *tekhelet* and the identity of the species that provided the dye, the *chilazon*. The *chilazon* had not been available to the Jews in Babylonia, where a large portion of the Jewish population lived at that time, and it had to be imported from the Jews living in Israel. When the settlement in Israel was lost, the *tekhelet* disappeared [5].

In this state, when the dibromoindigo is exposed to ultraviolet light, the bromine bonds break and the dibromoindigo transforms into indigo, changing the purple-blue color to blue.

The rediscovery of *tekhelet* required going back to ancient Torah and secular sources, so that the scientific discoveries regarding *tekhelet* could be verified by comparing newly unearthed possibilities for *tekhelet* to the original. In ancient times, *tekhelet* (royal blue) and *argaman* (Tyrian purple) were used in the garments of kings and priests and other highly placed people because of the dyes' rarity; therefore a Jewish man wore a thread of *tekhelet* to remind him of his stature and responsibilities. The dyes for both *tekhelet* and *argaman* were obtained from the glands of snails found in the Mediterranean Sea. One of the major problems of reproducing the dye is distinguishing between *tekhelet* and *argaman* [6]. An important aspect of identifying the source of the original *tekhelet* is ensuring that the color of the dye produced is in fact the authentic blue color and not purple or a different shade of blue.

The Talmud in *Bava Metsia* explained that because the *tekhelet*

dye was a scarce resource, a cheaper counterfeit dye, obtained from a vegetable source, surfaced. The cheaper alternative, *kela ilan,* is usually identified as the color indigo, the color of the clear sky. The Talmud stated that this dye was outwardly indistinguishable from the true *tekhelet*, but it was forbidden to be used in place of *tekhelet*: the proper source of the *tekhelet* was the *chilazon*. The Talmud provided us with several details regarding the *chilazon*'s identity. It is found along the northern coast of Israel and its color is similar to the color of the sea. It has a shell, but its form of procreation is similar to that of a fish. The Talmud additionally noted that the dye must be taken from the *chilazon* while it is alive. The characteristics of the *chilazon* described in the Talmud have been used in modern efforts to find the source of *tekhelet* [6].

In the mid-nineteenth century, Rav Gershon Henokh Leiner of Radzin (known as the Radziner Rebbe) took it upon himself to find the long-lost *chilazon*. He had heard that a type of squid, the cuttlefish, *Sepia officinalis*, fit the description of the *chilazon*, and was convinced that this was the source of the dye. Rav Isaac Herzog, the first Chief Rabbi of the State of Israel, suggested that the Radziner Rebbe consulted with chemists and determined how to transform the black ink excreted from the squid into a blue hue. Within a year, ten thousand of his followers were wearing the blue strings on their *tzitzit* [7].

In 1913, Rav Herzog sent samples of the Radziner Rebbe's *tekhelet* to be examined by chemists and dye experts. The results, rather than confirming that the Radziner Rebbe's *tekhelet* as the organic indigo, showed that it is an inorganic dye known as Prussian blue, or ferric ferrocyanide. The process that the Radziner Rebbe used to produce his dye was to heat the squid ink to very high temperatures and then to add iron filings. Under these conditions, the organic molecules break down and the carbon and nitrogen recombine with the iron, which yields the Prussian blue dye. The test results proved that the *Sepia officinalis* was not the *chilazon,* because any organic substance could have been substituted for the squid ink [7]. For example, the original Prussian blue was manufactured using ox blood [5]. The structure of the squid's molecules do not factor into the process, which is dependent only on the elemental components – iron, carbon, and nitrogen. Therefore, Rav Herzog determined that the *Sepia officinalis* could not possibly be the *chilazon* [7].

A few additional discrepancies questioned the identification of the source of *tekhelet* as the *Sepia officinalis*. First, cuttlefish are very common and were a common source of ink in ancient times, which is inconsistent with the Talmud's description of *tekhelet* as very expensive. Second, the Talmud says that the *chilazon* can be found buried in the sand, but the cuttlefish cannot exist in sand. Third, according to the Talmud, the *chilazon* has a hard shell that must be cracked, and the cuttlefish does not have an external shell. Last, *tekhelet* is supposed to be a permanent dye, but Prussian blue washes out with soap. For these reasons and because of the vague and indirect relationship between the Radziner Rebbe's source of *tekhelet* and his final product, Rav Herzog concluded that the *chilazon* was not the *Sepia officinalis* [5].

After disproving the Radziner Rebbe's *tekhelet*, Rav Herzog attempted to find a different possible source of *tekhelet*. Rav Herzog looked into the *Murex trunculus* in particular, and showed conclusively that these snails were used in ancient times as a blue dye. He noted that it is very difficult to argue that the Jews used a different source of blue dye than the rest of the ancient world and that this source was unknown to ancient scholars and left no archaeological evidence. He could not conclusively prove that the *Murex trunculus* was the *chilazon* due to a few inconsistencies, which were later resolved by modern experts. The biggest problem was that the dye obtained from the snail was a blue-violet color and not the sky-blue color with which the *tekhelet* is generally associated [7].

In the early 1980s, Otto Elsner of the Shenkar College of Fibers discovered the solution to Rav Herzog's problem. He noticed that wool that was dyed from the *Murex trunculus* on cloudy days tended toward purple, while wool that was dyed on sunny days was pure blue. After investigating the photochemical properties of the *Murex trunculus* dye, he found that the dye was in a reduced state, and it was the exposure to ultraviolet light that would transform the blue-purple color to blue [7].

Precursors to the dye exist as a clear liquid in the hypobranchial gland of the *Murex trunculus*. The indigo molecule contains indole, a toxic waste product, so the *Murex trunculus* neutralizes the indole with sulfur, bromine, and potassium, and these resultant molecules are the precursors to the dye. When the precursors are exposed to sunlight and air, in the presence of the enzyme purpurase, which also exists in the gland, they turn into the dye material. The dye must be taken from the *chilazon* while it is still alive, because the purpurase quickly decomposes, so the gland must be smashed soon after it is taken from the live snail. The reactions that occur when the precursors are exposed to sunlight in the presence of the enzyme result in a mixture of dibromoindigo (purple) and indigo (*tekhelet)*. The dye is reduced and put into solution so that it binds tightly to wool. In this state, when the dibromoindigo is exposed to ultraviolet light, the bromine bonds break and the dibromoindigo transforms into indigo, changing

the purple-blue color to blue [7].

Elsner's results were consistent with a study by Wouters and Verhecken using high performance liquid chromatography, which determined that the dye from the *Murex trunculus* contained indigotin, 6-monobromoindigotin, and 6,6'-dibromoindigotin. They discovered that the *tekhelet*, indigotin, gets its color from a strong absorption peak centered at 613 nanometers. This is a significant discovery, because many scholars had struggled with matching the colors of dyes, but an absorption peak is like a fingerprint for the molecule in that it is a unique way of identifying the molecule by color. For example, an absorption peak would be one way of distinguishing between Prussian blue and *tekhelet* [8].

Although it cannot be determined with absolute certainty that the *Murex trunculus* is the source of *tekhelet*, this identification has much merit. *Murex trunculus* fits the criteria set forth by the ancient sources. The shells have coatings that have a blue or green coloring which fits the description of "similar to the sea." The snail is also extremely rare, making the dye very expensive, as the *tekhelet* is said to be in the ancient sources. In the late 19th and early 20th century, archaeologists found a large number of broken *Murex* shells, consistent with the method needed to extract the dye. In addition, if one opens a *Murex trunculus* snail and squeezes the hypobrachial gland, one will obtain clear mucus which will eventually change in color to purple. When the purple mucus is exposed to direct sunlight during the dyeing process, the dye is changed from purple to blue [5]. Although many *poskim* agree with the identification of *Murex trunculus* as the *chilazon*, this identification is likely to remain a controversy for a long time, because it cannot be made with absolute certainty, and it will likely take years of debating before a consensus is reached. ■

ACKNOWLEDGEMENTS

I would like to express my sincere gratitude towards Dr. Babich for providing the sources for this article. Additionally, I would like to thank my parents for supporting my education and for their constant encouragement.

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THE JEWISH STANCE ON ORGAN TRANSPLANTATIONS

Eliana Kohanchi

Over the past few decades, modern medicine has dramatically improved the lives of many individuals. Among these developments, organ transplanting has proven to be one of the most influential and positive advancements. Although these transplants serve to lengthen the lives of many ill patients, whether or not these procedures are permissible according to Judaic law (*halacha*) is unclear. There are many references to organ transplantations throughout the Torah, Talmud, and *halachic* literature that help guide the Rabbis of modern times to permit or prohibit these procedures.

The first surgical procedure as recorded in the Torah, occurred when G-d split Adam into two parts, a male and a female, indicating some form of a siamese section. This procedure was unique in that Adam served as both the donor and the recipient. A piece of Adam was taken away and given to him again, in the form of a partner. Prior to the surgery, the Torah reported that G-d searched for a life partner for Adam, but failed to find one. The fact that G-d only performed the operation when there was no other alternative suggests that transplantations can only be performed if completely necessary and nothing else can be done to save an individual's life [1]. Once the doctors have reached the conclusion that no other alternative exists, an organ transplant is a considerable option to save a life.

Additionally, *halacha* makes a distinction between cadaver transplants, organs transplanted from a dead body into a living person, and live donor transplants. There are three major *halachic* problems regarding cadaver transplants. The first is an issue of *nivul hamet*, mutilation of the dead. The Torah clearly stated,"And if a man has committed a capital crime and was executed, you shall hang him upon a tree but do not allow his body to remain on the tree all night" (Deuteronomy 21: 22-23). The Talmud taught that any type of desecration of a dead body is included in this prohibition (*Sanhedrin* 47a). Furthermore, the Talmud discussed a case of examining a dead body to check the internal organs for wounds, concluding that this procedure was considered a desecration of the body, and is prohibited (*Hullin* 11b). Accordingly, removing an organ from a dead body would be a mutilation, and thus, it is not *halachicly* permissible. The second problem with a cadaver donor is found in the Talmud, where it explicitly stated that there is a prohibition against deriving any benefit from a dead body, known as *issur hana'ah* (*Sanhedrin* 47b). Lastly, the Torah wrote, "Thou shall surely bury him" (Deuteronomy 22:23), from which the positive commandment to bury the dead is derived. The Talmud added a negative commandment associated with the burial that prohibited the removal of any organ or limb from the body (*Sanhedrin* 46b). Thus, cadaver transplants would seem to violate this commandment, as they require the removal of an organ from the dead body, disabling it from being fully buried [2].

This procedure was unique in that Adam served as both the donor and the recipient.

When receiving organs from a dead body, many Rabbis debate upon how to define death. According to Rabbi Dr. Bleich, brain death and irreversible coma do not define one as dead. Rather, according to *halacha*, death is defined as the total cessation of both the cardiac and respiratory systems, which needs to occur long enough for revival to be impossible. Rabbi Dr. Moshe Tendler maintained that irreversible brain death is considered death even if one's heart is still functioning. The *halachik* definition of brain death remains a debate. However, an organ removed from a brain dead patient who is not considered to be *halachikly* dead is hastening his death. The donor cannot be prepared for this procedure because it will shorten his life, which is considered to be an act of murder [3]. For an individual who is considered to be dead according to *halacha*, the general consensus among the Rabbis is that saving a life, *pikuach nefesh*, overrides desecrating a dead body, deriving benefit from a corpse, and burying a full body with all organs intact. However, mutilation of the body should be kept to a minimum and all remaining parts that are not used for the transplant should be treated with respect and buried with the corpse. If the person is not considered to be dead, the Torah prohibited rushing of one's death to save another life. [1].

Organ donations can be received from live patients as well.

However, one who undergoes a surgical procedure to remove an organ places himself into a *safek sakkanah*, a potential danger to his life [4]. Kidney and liver transplants are commonly more successful when received from living donors. Kidney transplants have become a common procedure for those with kidney dysfunction. The kidneys regulate the body's electrolyte and water balance and eliminate waste products from the body. When both kidneys fail, the patient can undergo a dialysis procedure or a kidney transplant. Over the past few years, transplants have proven to be a more successful procedure than the dialysis option [6]. Moreover, a donation from a live donor has been proven to be more successful than that from a cadaver [1]. Rabbi Immanuel Jakobovits stated that a donor may remove a kidney from his own body, endangering his own life, to supply a "spare" organ to a recipient whose life would be saved. However, he may donate his kidney only if the probability of saving the recipient's life is greater than the risk posed to the life of the donor [5]. Since the risk to the donor with two healthy kidneys is minimal, it seems that kidney donations are permitted. However, there is no obligation for one to put himself at this risk nor should one be pressured into placing himself in this position [1]. Rabbi Eliezer Waldenberg and Rabbi Shlomo Zalman Auerbach have agreed that kidney transplants are permitted from both cadavers and living donors because the donor still has one viable kidney [7].

G-d gave man two kidneys, but only one liver. The liver is a large organ, but one can function without its entirety. When the liver fails, whether due to infection or autoimmune disease, a transplant is needed to allow the patient to live. Unlike kidney transplants, dialysis is not an option for liver failure. Cadaver liver donations are not as successful as donations from living donors. When part of the donor's liver is removed, it only takes a few months for the liver to grow back to its original size and function normally. However, this surgery is complex, causing a significant rate of death for both the recipient and the donor. In fact, almost all liver donors and recipients contract some form of illness from the transplant procedure [7]. In this case, is the donor permitted to risk his life for the sake of *pikuach nefesh*?

The Torah stated, "only beware for yourself and greatly beware for your soul" (Deuteronomy 4:9) and "you should take great care for your souls" (Deuteronomy 4:15). The Talmud and the *Rambam* explained that these verses refer to the necessity of removing all danger from one's physical wellbeing. Furthermore, one may not wound himself or set aside his life for that of another. The Talmud *Yerushalmi* concluded that one is obligated to place himself into a potentially dangerous situation in order to save the life of another. It is certain that the recipient of the organ will die without the transplant but it is only a possibility that the donor will die due to the procedure [5]. On the contrary, the *Chafetz Chaim*, author of the *Mishna Brurah,* explained that one is not obligated to save another's life if he poses a potential risk to himself (*Orach Chayyim*, 329). The *Chafetz Chaim* elaborated that the minor risk to the donor takes precedence over the absolute risk to the recipient. However, the *Mishna Brurah* also noted that one should not count his odds too carefully. For example, one should not avoid visiting a sick patient in the hospital, because a car might hit him while he is crossing the street. If the risk is reasonable, one is permitted, but not obligated to take it. The *Aruch Hashulchan* emphasized that saving one life is like saving the entire world [7].

He may donate his kidney only if the probability of saving the recipient's life is greater than the risk posed to the life of the donor

In the *Gemara*, an argument is recorded regarding how much of the liver must remain in an animal for it to be considered kosher. According to one opinion, only the most minimal amount must remain, indicating that the liver is not a major life-sustaining organ. Conversely, the other opinion, which is accepted as the *halacha*, maintained that the liver is a life-sustaining organ, and therefore, requiresd a minimum of the size of an olive in volume for the animal to retain its kosher status (Chulin, 46a). *Rashi* explained, based on this *Tosefta* in Chulin, that this olive size is the amount of liver necessary for the liver to produce healing and perform its life-sustaining function. Dr. J.L. Kazenelson explained that the word "produce" indicated that the liver will actually regenerate new liver material, until the entire liver was healed. Modern science did not record this until 1894, when two German scientists discovered that the liver could regenerate even after the removal of 7/8 of the organ. Secular scholars in ancient times, such as Aristotle and Galen, only understood that the liver was delicate and vulnerable to any minute injury. However, the *Tannaim* taught and applied the regenerative potential of the liver, a discovery that was not found by the western world until fifteen hundred years later [8]. ■

ACKNOWLEDGEMENTS

I would like to thank my parents for all of their emotional support. I would also like to thank Rabbi Shmalo for reviewing the Torah content of this article and Dr. Babich for all his help in finding the information necessary to write this article and for editing its scientific content. Additionally, I would like to thank Emma Teger for her grammatical editing.

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INSIGHT INTO YITZCHAK'S EYESIGHT

Batsheva Kuhr

An intriguing instance in which a combination of Torah and medical sources can help shape a theoretical diagnosis is the case of Yitzchak's eyesight. In *Bereishis* (27:1), the Torah stated, "when Yitzchak had become old and his eyes dimmed from seeing…" This phrase is mentioned as an introduction to the episode where Yitzchak attempted to bestow blessings on Esav, but ended up conferring them upon Yaakov, whom he thought was Esav due to the "dimness" of his eyes.

It is very possible that the diminishment of Yitzchak's eyesight occurred through means of nature and intensified by air pollutants and his study habits. Suggested diagnoses include cataracts [1], glaucoma [1, 3], presbyopia [1], macular degeneration [1, 3], visual agnosia [1], adult-onset diabetic retinopathy [2], open-angled glaucoma [3], trachoma [3], leprosy [3], onchocerciasis [3], and xerophthalmia due to hypovitaminosis A [3]. *Chazal* did not give any indication as to the specific medical prognosis of Yitzchak's diminished eyesight.

There are some sources that support the argument that Yitzchak's blindness occurred by natural means related to his advanced age (though there are no sources that indicate that his loss of vision stemmed solely due to the fact that he had aged). It should be noted that when reference is made to something "natural" the intent is that the event occurred solely by Divine intervention through pathways within the natural world, as opposed to a rare condition or a sudden inexplicable onset.

One convincing argument as to the natural cause of Yitzchak's dim vision being attributed to aging comes directly from the Torah. The *pasuk* stated, "when Yitzchak had become old and his eyes dimmed from seeing…" indicating that the reason his eyes "dimmed" was due to his aging. The next *pasuk* (27:2) stated that Yitzchak said to Esav, "see now that I have aged," as if to 'sandwich' in the statement of his dim eyesight with an emphasis on his elderliness, indicating that his eye condition was age-related.

Additionally, in reference to Eli's dimming of the eyes, where the identical term of "dimming," *keha*, is used, the Rashbam explicitly stated that it was "*min haziknah,*" "from the old age" (*Shmuel* I 3:2).

This language of "*keha*" was also used in regard to Moshe, except in this case the statement was the opposite. Moshe's eyes "did not dim" at the age of 120 (*Devarim* 34:7). One suggested interpretation (that is not discussed by *Chazal*) is that eye dimming was a rare condition and Moshe was part of the majority elderly population whose eyes did not dim [1].

If one were to consider the possibility that Yitzchak was exposed to similar smoke in his own household, this would only substantiate the evidence that Yitzchak had age-related macular degeneration.

However, an overwhelming amount of evidence supports the contrary claim that the statement of Moshe retaining his visual capacity emphasized that Moshe was exceptional in that his visual acuity did not diminish. The Ramban similarly argued that Yitzchak's dimness of the eyes was a natural manifestation of elderliness, just as Yaakov's blindness was (48:10). Dr. F. Rosner concurred, stating that it was the exception that Moshe was 120 years old, yet his eyes did not dim [4, 8].

A major cause for the intensification of Yitzchak's dim eyesight, if not the primary cause of the condition, is from the smoke from the sacrifices and incense offered to idols by Esav's wives, as Rashi informed above. As *Mishlei* pointed out, smoke is harmful to the eyes (10:26). Though this is not a shocking revelation, it is interesting to note that various combustion by-products, such as sulfur dioxide, ozone, and particulate matter from the burning of sacrifices and incense irritate eyes and worsen preexisting visual problems [5]. Specifically, cigarette smoking has been linked to age-related macular degeneration [6]. If one were to consider the possibility that Yitzchak was exposed to similar smoke in his own household, this would only substantiate the evidence that Yitzchak had age-related macular degeneration.

Another factor that may have affected Yitzchak's eyesight was the amount of time he spent learning. The *Gemara* and espe-

cially the Maharsha on *Yoma* 28b stated that Yitzchak and Yaakov became blind in old age due to their excessive time in study of Torah, their eyesight weakened and eventually was lost. Interestingly, modern studies have found similar discoveries. In one such study, the frequency and degree of myopia (nearsightedness) in Yeshiva-attending Jewish males was significantly greater than their secular-school-attending Jewish counterparts [7]. The conclusion of the increased myopia was attributed to the study habits of the individuals, especially related to the format of the text used. Though this was not the case for these Patriarchs (Yitzchak and Yaakov did not have *gemaras* with small print), the conclusion is still the same: eyesight may be weakened due to extended study.

However, diminished eyesight was not to Yitzchak's detriment; according to the *Tanchuma* (based on Rashi in *Bereishis*, cited in the Artscroll Stone Edition of the *Chumash*), Yitzchak's loss of the full extent of his visual capacity alleviated him of any emotional or spiritual pain stemming from seeing his offspring worshipping idols. So in an alternate interpretation, as a reward for his Torah studying, G-d spared him the pain of witnessing his household members serve idols by dimming his eyesight.

Additionally, the *Midrash* in *Bereishis Rabbah* 65 relates that Yitzchak asked G-d to let him suffer in this world so that his sins will be atoned for before reaching the World to Come. G-d agreed to his request and Yitzchak became blind. In this *Midrash*, Yitzchak's old age was not a cause of his diminished eyesight. Rather, Yitzchak's advancement in years was the catalyst to request atonement from *Hashem*. The reason why *Hashem* specifically made him lose his visual capacity as the source for his atonement is because *Hashem* was "setting the scene" for Yitzchak being incapable of identifying onto whom he was bestowing the blessings. The same *Midrash* mentions that Yitzchak's lost eyesight was a fulfillment of the *pasuk* that a person who takes a bribe is blinded (*Shemos 23:8).* Meaning, explains the *Midrash,* that Yitzchak was punished with blindness for having allowed himself to be "bribed" by Esav with the gifts of food that he brought.

An interesting point to mention is that Yitzchak asked Esav to bring him some sort of meat, as he said, "go out to the field and hunt for me…[t]hen make me delicacies" (*Bereishis* 27:3,4). In *Pesachim* 42a, it is written that, among other things, fat meat gives light to the eyes [8]. It is conceivable that Yitzchak, whose eyes were dim, desired to brighten them prior to bestowing the blessings on his son by consuming meat, and specifically "delicacies," which likely may have been fatty meat since fattening foods in that era were considered delicacies.

In conclusion, any and possibly all of the factors and options mentioned in this article could have been causes for the "natural" decline of Yitzchak's vision. One can see how science can be applied to details and facts that are presented in the Torah. With even a modest amount of knowledge about what the commentators say on the issue and scientific research, one can suggest possibilities regarding the nature of a condition, thus harmonizing the world of Torah and science. ■

ACKNOWLEDGEMENTS

I would like to thank my parents and brothers for their encouragement and endless faith in me. I wish to also express my gratitude to every single one of my teachers for their continuous support in all of my endeavors. A special thank you goes to Dr. Babich who encouraged me and was an invaluable resource to the start, middle, and end of this article. Thank you to Rabbi Reuven Lauffer of Jerusalem who took the time out to comprehensively review the manuscript and add in many important enhancements. Most importantly, I would like to thank G-d for His infinite kindness I am privy to at every moment. *Baruch she'hechiyanu.*

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LAVAN'S REAL PERSONALITY

Katie E. Liebling

The infamous Lavan, brother of Rivka Imenu, is known to all as an evil individual through both the Biblical narrative as well as the commentaries. What is not discussed, however, is how we may categorize Lavan's behavior in light of the current classification of personality disorders. The Diagnostic and Statistical Manual of Mental Disorders (DSM), published by the American Psychiatric Association, provided standardized criteria for the classification of psychological disorders. The category of personality disorders was divided into three clusters: A—odd or eccentric, BB —dramatic, emotional, or erratic, and C—anxious or fearful. Within cluster B, lies Antisocial Personality Disorder, one that is characterized by a pervasive pattern of disregard for and violation of the rights of others [1]. It seems plausible that Lavan can be classified as having had Antisocial Personality Disorder.

Dr. Robert Hare, a criminal psychologist, described individuals with antisocial personality disorder as "social predators who charm, manipulate, and ruthlessly plow their way through life, leaving a broad trail of broken hearts, shattered expectations, and empty wallets. Completely lacking in conscience and empathy, they selfishly take what they want and do as they please, violating social norms and expectations without the slightest sense of guilt or regret." Included in this constellation is pathological lying, superficial charm, grandiose sense of self-worth, need for stimulation, and lack of remorse. Antisocial Personality Disorder was formerly referred to as sociopathy or psychopathy. The latest DSM (DSM-IV-TR) criteria for antisocial personality disorder focused more on observable behaviors, rather than on psychopathic personality traits [1].

At the onset, Lavan is revealed to have been a greedy person in parshat Chayei Sarah. When Eliezer came to Lavan's family to ask the father, Betuel, if he can take Rivka, Lavan's sister, as a bride for Yitzchak, Lavan ran out to greet him. Rashi explained that Lavan impulsively ran only because he saw Rivka with a nose ring and bracelets and realized that Eliezer was a wealthy man (*Breishit* 24:29). In *parshat Vayeitzei*, Rashi explained that Lavan remembered Eliezer, the servant of Avraham, coming with riches to see Rivka and surmised that Yaakov, Avraham's grandson, must have come with even more. When he hugged Yaakov to welcome him, Lavan's true intention was to determine how filled Yaakov's pockets were with money (*Breishit* 29:13). Upon finding the pockets empty, Lavan kissed Yaakov to see if he had pearls in his mouth. Much to his dismay, Lavan found nothing and subsequently invited him into his house for no reason other than "you are my bone and my flesh" (*Breishit* 29:14). The *Midrash* in *Breishit Rabbah* (70:19) explained that Lavan's invitation to Yaakov was meant for only a month, and during this time, he required Yaakov to tend to his flocks at half the going wage [3].

> It seems as if Lavan regretted his previous intent to harm his family. His subsequent behavior, however, indicated that this remorse was not lasting and, perhaps, never even real.

Realizing that Lavan was a cheater, Yaakov was very specific in his request for Rachel's hand in marriage (*Breishit* 29:18): "For Rachel, your daughter, the younger one." Rashi explained that Yaakov expressed his request in such detail so that Lavan would not give him a random Rachel from the marketplace or change Leah's name to Rachel. Yaakov went so far as to create special signs with Rachel with which he could identify her. Despite all of this, Lavan still deceived Yaakov and, instead, clandestinely gave him Leah, to whom Rachel had given the identifiers in order to prevent her sister's embarrassment (Rashi in *Breishit* 29:25). Lavan gave Zilpah to Leah as a maidservant for a wedding present to further mislead Yaakov. Rashi (*Breishit* 30:10) pointed out that Zilpah was the younger of the two maidservants, corresponding to the younger daughter, Rachel. The *Avnei Shoham* mentioned that Lavan even cheated Zilpah by not indicating to whom she was being given [2].

Lavan also behaved deviously with the people of Charan. It was acknowledged by all that their waters were blessed because of the righteous Yaakov's presence, since prior to his arrival, wa-

ter was sparse. In manipulating the townspeople to participate in Yaakov's deception, Lavan convinced them that switching Leah for Rachel would cause Yaakov to remain in their land another seven years while working for Rachel. As a result, the townspeople would continue to be blessed with water. Lavan forced the people to give him securities that he used to buy wine, oil, and food. He was, therefore, known as Lavan HaArami, (ramai), meaning "Lavan the deceiver" (*Breishit Rabah* 70:19) [3]. Moreover, *Oznayim LaTorah* explained that Lavan justified the switch of his daughters with the town's custom of not giving the younger to be wed before the older [2].

The Abarbanel commented that Lavan publicized Yaakov's wedding to encourage the townspeople's participation in the celebration and, thereby, to cause Yaakov to be ashamed to divorce Leah once she was revealed to him. Lavan did not make a feast for Rachel's marriage to Yaakov, explains the *Torah Temimah*, because there was no longer a need to confuse him [2]. Perhaps an additional motive of Lavan in making the feast for Leah was to charm the masses and ingratiate himself in their eyes.

The Chofetz Chaim explained that Lavan attempted to justify his machinations by claiming that he had to give Leah to Yaakov first in order to keep his promise. Because of the custom of the land, Lavan could only give Rachel to Yaakov by marrying off Leah first. Lavan said that by asking for the younger sister first, Yaakov, in fact, implied the older as well. Moreover, Lavan behaved as if he were doing Yaakov a favor by giving him Rachel right away and allowing him to work for her on credit [2].

Lavan continued to swindle Yaakov throughout his tenure. When Yaakov worked additional years for Lavan to make a livelihood, he agreed to take the speckled, dappled, and brownish lambs, sheep, and goats. Yet, Rashi (*Breishit* 31:7) noted that Lavan changed his mind and the terms of the agreement 100 times!

Lavan's own daughters were not immune to their father's criminality. When Hashem told Yaakov that it was time to return to his birthplace, Leah and Rachel readily accepted. They responded by saying (*Breishit* 31:15), "Are we not considered to him as strangers?" We learn from Rashi that Lavan did not even treat them like daughters. He did not provide a dowry for them at the time of marriage and tried to withhold funds by cheating Yaakov. (*Breishit* 31:15). Lavan even cheated his own daughters!

When Lavan learned that Yaakov departed with his family, he immediately pursued them, caught up with them, and said, "There is power to my hand to do you harm" (*Breishit* 31:29). By using the word "you" in the plural, he not only wanted to do evil to Yaakov but even to his daughters and grandchildren as well. It was only because Hashem warned him not to say to Yaakov "good or bad" (*Breishit* 31:24) that Lavan did not actually destroy his own family [2].

After this incident, Lavan decided to make a covenant with Yaakov and said, "The daughters are my daughters, the children are my children… What could I do to them this day?" (*Breishit* 31:43). It seems as if Lavan regretted his previous intent to harm his family. His subsequent behavior, however, indicated that this remorse was not lasting and, perhaps, never even real.

Targum Yonatan in *Bamidbar* (22:5) and *Yalkut Shimoni* in *Shemot* (168) noted that Lavan and the wicked Bilaam were one and the same.[1] Lavan was called Bilaam because he wanted to devour, *livloah*, *Bnei Yisrael* (*Targum Yonatan* in *Bamidbar* 22:5). The Zohar (1:133b), however, says that Lavan was Bilaam's grandfather, and the Gemara in Sanhedrin 105a states that Lavan was Bilaam's father. In either case, Bilaam would be fulfilling Lavan's mission as his descendant. When Pharaoh said, "Let us deal wisely with them" (*Shemot* 1:10), referring to his plan to control the Jewish people, the Gemara (*Sota* 11a) described how Bilaam spoke up and advised Pharaoh to slay them. The Midrash Aggadah in *Bamidbar* (22:21) commented that Yaakov foresaw that Bilaam would be part of Pharaoh's council. As a bribe, Yaakov, therefore, gave the talking donkey that Hashem created on the sixth day of creation to Lavan. In exchange for this, Lavan was expected to withhold evil advice against the Jewish people. However, Bilaam suggested that Bnei Yisrael should make bricks (*Midrash Aggadah* in *Bamidbar* 22:21), perpetually remain in bondage (Zohar 3:212a), and that their babies be thrown into the Nile (*Yalkut Shimoni* in *Shemot* 168). He also recommended to Pharaoh that he bathe in Jewish blood to heal his leprosy (*Midrash Hagadol*, *Shemot* 2:23) and that Moshe be killed for removing Pharaoh's crown and placing it on his own head (Yalkut Shimoni in *Shemot* 166) [3].

When Balak sent officers to hire Bilaam to curse *Bnei Yisrael*, he first asked Hashem's permission, but Hashem denied this request (*Bamidbar* 22:12). The *Midrash Shocher Tov* (1:22) commented that Bilaam thought that it was because he, himself, was such a righteous individual that Hashem did not wish to trouble him [3]. Additionally, Bilaam said to the officers, "Hashem refuses to allow me to go with you" (*Bamidbar* 22:13). Rashi (*Bamidbar* 22:13) explained that Bilaam was too haughty to admit that he was un-

[1] Assuming that *Lavan* was approximately 10 years old when *Rivka* married *Yitzchak* and and knowing that Lavan/Bilaam was killed in the 40th and final year of *Bnei Yisrael's* sojourn in the desert, *Lavan* would have lived approximately 417 years. This is plausible given that there were people of that era who lived for 500-600 years.

der Hashem's authority and, instead, implied that he could not go with the "lowly" officers that had been sent and demanded greater. Such behavior clearly demonstrated Bilaam's/Lavan's grandiose sense of self-worth.

When Hashem let Bilaam go with Balak's officers and commanded Bilaam to do what He said, Bilaam became so excited that he saddled his own donkey. Rashi (*Bamidbar* 22:21) explained that Bilaam himself impulsively saddled his own donkey instead of having his servants because his intense hatred disrupted the normal progression of things. In contrast, Avraham, himself saddled his own donkey out of his love for Hashem and wanting to do His Will by preparing Yitzchak for the akeidah (Rashi, *Breishit* 22:3). While impulsivity is a state of being, Avraham used it for the good and Bilaam used it for evil. Hashem, therefore, called Bilaam a rasha (Rashi, *Bamidbar* 22:21). This impulsivity fulfills one of the criteria for antisocial personality disorder.

Every person is presented with different tests and challenges. However, it is one's reactions and attitudes to these challenges that define the essence of the individual.

Although Bilaam was a prophet, his great powers came from his mastery of sorcery and black magic. This is why he is called, "Bilaam *Hakosem*," Bilaam the Sorcerer (Ramban in *Bamidbar* 22:31). Illusion is a major contributor to the impure forces behind sorcery [4]. The sorcerer can make someone believe that he is seeing an event which is really not happening by incorporating trickery, slyness and confusion. The synthesized identity of prophet and sorcerer in and of itself generates confusion. When Pinchas and Bnei Yisrael killed Bilaam, Bnei Yisrael were worried saying, "What have we done?! We have slain a prophet of whom it is written, 'Who knows the knowledge of the Most High'" (*Bamidbar* 24:16). However, a heavenly voice descended and said, "You have slain a sorcerer, not a prophet" (*Otzar Hamidrashim* 168) [3]. This deceitfulness fulfills another criterion for the diagnosis of antisocial personality disorder.

Antisocial personality disorder does not affect the ability to reason. There is no evidence of brain impairment as those who have this disorder score normally on neuropsychological testing. Early theories suggested that psychopaths had abnormally low levels of cerebral cortical arousal in their brains and a higher fear threshold. They seek stimulation, intrigue and adventure without concern for consequences. For example, they steal without fear of being caught. It is thought that the reason for the lack of anxiety in committing antisocial behavior is due to an imbalance of the Behavioral Inhibition System (BIS) and the reward system. The BIS, thought to be located in the septohippocampal system involving the noradrenergic and serotonergic neurotransmitter systems, is responsible for one's ability to stop or slow down an action when faced with impending punishment or danger. The BIS is also associated with the fight or flight system, which helps one decide to fight against or flee from an impending danger. The reward system, located in the mesolimbic area of the brain and involves the dopaminergic neurotransmitter system, is responsible for one's approach to positive rewards. When there is an imbalance of the BIS and the reward system, the fear initiated by the BIS system is superseded by the positive feelings associated with the reward system. This may explain the lack of anxiety that the psychopath experiences when committing antisocial acts [1].

Whether generically called a psychopath or formally considered to have antisocial social personality disorder, Lavan is by all standards a wicked individual. Rashi (*Breishit* 24:50) explicitly called Lavan a *rasha*; Concerning Eliezer's request to immediately bring Rivka to Yitzchak, Lavan, not waiting for his father to respond, impulsively jumped to answer Eliezer. *Pirkei Avot* (5:22) related the three characteristics of the disciples of Bilaam: "An evil eye, a haughty spirit, and a lusting soul [3]." These are the characteristics of one who has antisocial personality disorder. When Lavan finally spoke sweetly to Yaakov saying, "I would have sent you out joyfully and with song, with drum and harp," (*Breishit* 31:27) Yaakov was terrified, thinking that he must have sinned in that "*tu'mah*, impurity, and *kedusha*, sanctity, cannot dwell side by side [2]." A person like Lavan has full reasoning capability and can restrain himself from performing criminal acts. Perhaps, Hashem specifically related so much of Lavan's evil to teach us that although one may be tested with great desire for money, a high threshold for experiencing fear, and a cunning mind, he/she is still not permitted to succumb. Every person is presented with different tests and challenges. However, it is one's reactions and attitudes to these challenges that define the essence of the individual [5]. The Torah teaches us that although Lavan might have had such challenges, his reactions and intentions to them were all negative, thereby defining him as a *rasha* from whom to learn how not to behave.

DSM features of antisocial personality disorder include a person at least 18 years of age, failure to conform to social norms, deceitfulness including use of aliases, impulsivity, aggressiveness,

reckless disregard for the safety of others, consistent irresponsibility for payment, and lack of remorse for harming others [1]. It is fair to conclude that Lavan could be diagnosed with antisocial personality disorder. According to halachic standards, however, such a diagnosis does not preclude accountability for actions. ■

ACKNOWLEDGEMENTS

I wish to thank Rav Mordechai Tendler, Shlita, for his review of this article and genuine concern. I thank my parents for their unconditional support and assistance. Last, but by no means least, I extend warmest appreciation to Dr. Harvey Babich for his continual guidance and sincere kindness.

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FAMILIAL DYSAUTONOMIA AND THE PURSUIT OF GENETIC HEALTH

Miri Mandelbaum

In loving memory of Michael Zauder a"h, who inspired us with his strength and warmed our hearts with his smile.

Familial dysautonomia (FD) is an Ashkenazi Jewish genetic disease affecting the sensory and autonomic nervous systems. Among other symptoms, children born with the disease cannot control their blood pressure, body temperature, and heart rate. They have trouble swallowing and digesting food properly, have reduced sensitivity to pain and temperature, and cannot produce tears [1].

An estimated, 1 in 27 Ashkenazi Jews are carriers of the FD mutation [1]. The mutation is found on the long arm of chromosome 9 (on the IKBKAP gene). Since the mutation is recessive, a person will only exhibit the FD trait if he carries the mutation on both #9 chromosomes. A heterozygote, with one mutated and one normal functioning gene, is a carrier of FD. Although he will not exhibit any adverse symptoms, if he conceives a child with another carrier, there is a 1 in 4 chance that their child will inherit the mutation from both parents and will have the disorder [2].

It is speculated that the FD mutation originated in Eastern Europe as a result of the founder effect [3]. The Ashkenazi Jewish population descended from a significantly small number of ancestors. Any mutations they carried were passed on to their children and amplified throughout the generations. The founder effect is one major cause of Jewish genetic diseases [4].

In Europe prior to the twentieth century, technology was not yet advanced enough to maintain the lives of FD babies. Because child mortality was fairly common, no attention was paid to these babies in particular. It was not until the 1940s that the disease was identified. Doctors Riley and Day, while working in Columbia Presbyterian Babies Hospital, discovered similarities between some of the sick babies. The disease they uncovered became known as Riley-Day Syndrome.

As modern medicine progressed, children born with Riley-Day Syndrome, also known as familial dysautonomia, began to live longer, allowing for more research [3]. Parents of children with FD founded the Dysautonomia Foundation in 1951, a public charity dedicated to improving the lives of people with FD [1]. In 1970, Dr. Felicia Axelrod formed a treatment center for these children at New York University Medical Center.

Towards the end of the 1980s, scientists began to work to identify the gene carrying the FD mutation. Understanding the advantages of having the gene identified, Dr. Axelrod suggested that the Dysautonomia Foundation fund the discovery of the gene. A Harvard Medical School laboratory funded by the foundation discovered genetic markers, i.e., similar DNA sequences, within FD families. The markers did not identify the FD gene, but they did open the option of preimplantation genetic diagnosis (PGD) for couples who already had a child with FD. PGD is a procedure developed by Jewish researchers, originally to allow carriers of the Tay-Sachs gene to have healthy children. In this procedure, cells from a preembryo produced by *in vitro* fertilization (IVF) are tested for mutations before being implanted in the mother. In the case of FD, preembryo cells could be tested for the DNA markers common amongst FD families. This option was difficult, not 100% reliable, and could only be used for affected families. The gene carrying the FD mutation was identified in 2000. A carrier-screening test became available to the public in 2001 as an easy way for anyone to know if he carries the FD mutation.

An estimated 1 in 27 Ashkenazi Jews are carriers of the FD mutation.

Two different mutations on the IKBKAP gene account for 99% of FD cases. A third mutation was discovered in one or two cases. Dysautonomia treatment centers test patients for these mutations. If a patient does not carry one of the three known mutations, a new mutation can potentially be found.

By identifying the gene and through the use of modern technology, couples in which both parties carry the FD mutation can avoid conceiving a child with the disease. PGD is much more reliable now that the actual gene can be tested for instead of the DNA markers. Additionally, much genetic research is being done. By researching the discrepancies between what the gene should be doing and what it actually does, genetic therapies are being de-

veloped. These therapies try to correct the gene by constructing the correct protein. Another research methodology is through laboratory animal models. The defective gene is inserted into the genome of an animal, commonly a mouse. Researchers can perform tests on the animal to learn more about the effects of the mutation and how it can be corrected [3].

The Dysautonomia Foundation, headquartered in New York City, continues to provide the largest source of funding for FD research. It also funds the world's two FD treatment centers, one at New York University Medical Center and the other in Hadassah Hospital in Jerusalem. As a result of the work of these centers, the quality of life for people with FD has improved significantly. Life expectancy has risen from 5 years to 40 years. However, affected individuals still suffer from symptoms that prevent them from leading normal lives [1].

With the availability of genetic screening for the FD mutation, the birth of children with FD can be completely avoided. However, as long as people remain unaware of the importance of genetic testing, not only for FD but for all genetic diseases, affected babies are still being born. Rabbinical leaders should be aware, ensuring that couples are tested before getting married. It is extremely important that couples know if they are carriers for a genetic disease before having children. Appropriate measures can then be taken to ensure the birth of a healthy baby [3]. ■

ACKNOWLEDGEMENTS

I would like to express my gratitude to Mr. David Brenner, Executive Director of the Dysautonomia Foundation, for all the assistance he provided me with the researching of this article. On behalf of myself and my family, I would like to acknowledge the tremendous work that Mr. Brenner does for individuals with FD. Thank you to Dr. Babich for his constant encouragement. A special thank you to my parents for their endless support.

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Sara Margolis

I always wonder what people think when they see me mumbling under my breath after I exit the restroom. Little do they realize the great importance and holiness of the words I am saying. The *bracha* of *asher yatzar* is rich with meaning, and there are many interpretations of each phrase.

In the beginning of the *bracha*, we acknowledge that G-d formed man, *b'chachmah,* with wisdom. The *Maharsha* brings up a few possible explanations for this phrase. The *chachmah* can refer to the wisdom of the Almighty in creating man, a very complex, delicate, and detailed being. A second explanation is that the *chachmah* also refers to the wisdom of man (*Brachos* 60a). When creating Adam, G-d bestowed in him the ability to make decisions, think, and use common sense. The two explanations work together beautifully. *Hashem,* in His wisdom, made man very complex with a very detailed and delicate body, yet He supplied man with a brain capable of knowing how to care for it.

There are many dangerous things in the world today—from terrorists and criminals to genotoxic agents and poisonous chemicals and from harmful fumes to natural disasters. Many of these risks are out of our hands, and we can only pray and hope that we will not encounter them. But there are a whole handful of ways we can use the *chachmah* that G-d graciously granted us, and avoid as many hazards as we can—by leading a healthy lifestyle [1].

It has been scientifically proven that tobacco use poses a definite health danger. In the numerous studies done, smoking has been linked to heart disease, stroke, lung cancer, pancreatic cancer, and many other serious diseases. In fact, most of the medical research community agrees that any amount of smoking will lead to physiological damage. If this is really the case, that smoking causes a definite health hazard and accelerates the approach of death, it may actually breach the Torah obligation of "*v'nishmartem meod l'nafshoseichem*" and the violation of harming oneself [1].

The smoking issue goes even further. The *Shulchan Aruch* discusses the prohibition for a Jew to strike another, and the Torah is even strict in regards to striking a wicked person. Since it is forbidden for one Jew to harm another, and inhaling second hand smoke is a health hazard, it therefore may also be *halachically* unlawful to smoke in another's presence. In fact, Reb Moshe Feinstein, *zt"l*, held that people who were harmed by other's smoking habits were even authorized according to *halacha* to file a suit for damages [1]. The best way to use our G-d-given *chachmah,* then, would be to avoid smoking—and denounce it in our communities.

Another way in which we can use *chachmah* is in choosing what to eat. A kosher-only diet already restricts much of the average supermarket. But it may be *halachically* necessary to restrict it even more, and make only healthy choices. In 2000, smoking was proven to be the leading cause of preventable death, but obesity was not far behind; in fact it came in second. Not enough attention is given in the *frum* communities to the importance of eating healthy foods, and avoiding trans fats and unhealthy food ingredients. The Rambam pointed out that it is possible to eat only kosher foods—such as avoiding milk and meat, pork, and shellfish—and still be *oveir* the *mitzvah* of "*kedoshim tihiyu*," which according to the Rambam is meant to warn people not to eat in glut. He stated in the Mishnah Torah that "overeating is like a deathly poison to the body, and is the root of all illnesses. Most illnesses that afflict a man are caused by harmful food or by overeating even healthy food" [2].

Hashem, in His wisdom, made man very complex with a very detailed and delicate body, yet He supplied man with a brain capable of knowing how to care for it.

Obesity poses a severe health risk, which is expressed in many ways: high blood pressure, high cholesterol, type 2 diabetes, stroke, gallbladder disease, heart disease, and respiratory problems—just to name a few. However, the obesity issue is not as clear cut as the smoking issue. First of all, some people are genetically predisposed to be heavier. Secondly, everybody needs to eat to survive; at what point would the extra bite become *halachically* considered too much [2]?

Although many *rabbanim* agree that smoking and eating

unhealthily are *halachically assur*, not all rabbis see eye to eye on this issue. Some bring up the source from *tehillim*, "*shomer petaim Hashem*" (G-d protects the simple), which is expounded upon in the Talmud and used as source of reliance on G-d for protecting people from the "everyday" dangers in life. (For instance, it permits people to engage in common but risky behaviors—such as driving.) But according to Rabbi Yaakov Ettlinger in his *sefer Teshuvot Binyan Tziyon*, this leniency can only be relied upon if the risk of danger is lower than 50%; according to the *Chasam Sofer*, this *passuk* is only valid when one is not fully aware of the dangers involved. Perhaps the *rabbanim* who claimed that smoking and overeating are not *halachically assur* were basing their decision on the scientific research of their times, and were not aware of all the health risks involved that we know of today. In the late 1990s, Rabbi Efraim Greenblatt stated that smoking is suicide; he compared the reliance on the "*shomer petaim Hashem" passuk* to allow smoking, to lying on the ground in the middle of a highway hoping that G-d will intervene! *Rav* Nebenzhal wrote that we surely cannot rely on the *passuk* because we see clearly that G-d is not protecting smokers from harm. In 2006, the Rabbinical Council of America (R.C.A.) issued a statement which expressed its firm belief that smoking is prohibited and that with today's scientific evidence, it would even be pronounced *assur* even by the earlier *rabbanim* who did not think it was [2].

Studies continue to support exercise as a source of improved health and longer lifespan. Besides lowering the risk of heart disease and stroke, staying physically active generally improves the body's functions and slows the aging process [3]. Using our G-d-given wisdom to live as healthfully as we can does not only include the preventative measures—like the avoidance of smoking and intake of trans fats. It is also important to be proactive about our health by exercising regularly.

Another related area, of using *chachmah* to live a healthy life, is making regular visits to the doctor and dentist—even for routine checkups or to inquire about a new symptom. Medical noncompliance, which comes in many forms—like not following a doctor's advice, turning to unreliable Internet sources for medical information, and heeding the medical advice from well-meaning neighbors, friends, and relatives—is a serious issue that plagues much of our society. [4]. The Meharsha, in his explanation of "*b'chachmah",* makes a distinction between man and other living things; *Hashem* gave special wisdom to man only which He did not grant to the animal kingdom (*Brachos* 60a). We, citizens of the human race, should not take our wisdom for granted. We have modern medicine and advanced scientific research, and we have doctors and dentists; medical noncompliance puts our *chachmah* to waste.

When I say *asher yatsar*, I try to think about the dual meaning of "*b'chachmah."* Hashem, in His infinite wisdom, made us intricate, complicated human creatures. And, He, in His unbounded kindness, gave us the special gift of wisdom to care for our bodies. As observant Jews, it is best to use our gift of *chachmah* to lead a healthy lifestyle—by not smoking, by eating right, by regularly exercising, and by pursuing proper medical guidance. ■

ACKNOWLEDGEMENTS

Thank you Dad for your research help and your editing skills. (And sinse I didnt let you read the aknowladgments, their are probabably at least a few typos hear…) Thank you Mom for always educating us to eat healthy and organic food (go quinoa!), to exercise, and to stay far away from smoking, food coloring, and other "poisons". (I am sorry for sometimes rebelling at the school snack machines.) Thank you Dr. Babich for encouraging me to write this article, for being a true role model, and for all your help and guidance along the way.

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HERMAPHRODITE: ANOTHER GENDER?

Juliet Meir

When we think of gender, we normally think of female and male. But what about individuals with ambiguous genitalia, *i.e.* hermaphrodites - how do we categorize them? This question is not as recent as it might seem; hermaphrodites have been discussed in rabbinic literature for centuries. Accordingly, these people are believed to be considered in one of five possible categories: male, female, part male and part female, a distinct *safek* (doubt) that will never be resolved, or *berya bifnei atzma,* "a unique creature with its own characteristics" [1]. It is also vital to understand that our sages qualify gender based on external organs only [2]; referring to vagina in the case of a female, and penis in the case of a male. In this article I will introduce the biological development of gender in the womb, then discuss the rabbinic decision of gender concerning hermaphrodites, and subsequently, elucidate hermaphrodites' position in the world based on their *halakhic* gender.

Gender determination extends from the time of conception to the time when the fetus' genital ridge becomes a bi-potential gonad. The genetic composition (XX or XY) of the fetus is determined at conception; however, the organ development of either ovaries or testes is predicated on the biochemical conditions [2] that are established at the time of expression or lack of expression of the SRY gene, which occurs either 40 or 80 days after conception, respectively [3]. In selective cases, there is an inconsistency between the genetic gender (XX or XY) and the external or internal organs, which can result in a hermaphrodite [2]. Some causes to produce a hermaphrodite include: the differential expression of alleles from cell to cell, due to fusion or infusion of foreign genetic material [1], double fertilization from more than a single sperm or egg [4], and postzygotic somatic point mutation in the SRY region of the Y chromosome [5].

The majority of *poskim* and *rishonim* hold that of the five gender possibilities of a hermaphrodite, its status is that of a *safek*. Accordingly, the majority of *rishonim* follow the opinion of the Rambam, who is the most stringent and who stated that a hermaphrodite [1], otherwise known as an *androginos* in Hebrew [6], is a "*safek if it is a male or female, and there is no sign by which it would be known conclusively if it is male or female.*" According to this view, a hermaphrodite would be obligated to follow all Jewish laws pertaining to both females and males because its gender status is in doubt [1].

It is in accord with this strict opinion that hermaphrodites must perform the following *mitzvot* like a male: They are required to have a *brit*; however, unlike for other males, the *brit* is performed without a blessing and cannot be done on Shabbat. In addition, a hermaphrodite is obligated to keep all time-bound *mitzvot* and is obligated to wear *tzitzit* and phylacteries [1]. On the other hand, he is not able to testify in court, receive the priestly gifts if he is a *cohen*, or serve as a priest in the *Beit Hamikdash* [6]. The only prohibition for which there is a leniency, and which differs among the different categories of hermaphrodite, is the prohibition of *yichud*. Rabbi Elyashiv quoted the *Ramah*, who said that the prohibition of *yichud* does not apply to a hermaphrodite who is significantly more one gender and is in the presence of that same gender [1]. There are many other questions, including whether hermaphrodites are required to go to the *mikvah* or obligated to cover their hair, depending upon their *halakhic* status.

After reading and trying to grasp all of this information, you may think that the probability of meeting someone or even knowing someone who is a hermaphrodite is uncommon and even not probable. However, according to some interpretations, *Adam Ha'Rishon* was a hermaphrodite. The Bible states "*male and female He created them*," and according to the interpretation of Rabbi Yirmiyahu ben Eleazar, that meant that Adam was a hermaphrodite [6]. At the end of the day, the gender of a hermaphrodite according to medical literature is that they are both male and female, and according to Jewish law, they are a *safek* that cannot be resolved. ■

According to this view, a hermaphrodite would be obligated to follow all Jewish laws pertaining to both females and males because its gender status is in doubt.

ACKNOWLEDGEMENTS

I would like to thank my friends Avigail Soloveichik and Jacob Chusid for their help editing my article. I would also like to thank Dr. Babich for finding the Judaic articles I used and for editing my paper. Lastly, but most importantly, I would like to thank my parents for supporting my education.

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DEFINING THE HUMAN SPECIES: AN EXAMINATION OF TRANSGENIC APES IN HALACHA

Leora Perlow

Scientists today are capable of inserting human DNA into species of the "great apes," granting them human characteristics. The transgenic product of such an experiment raises many moral and *halachic* (of Jewish law) issues. If enough human DNA is added to an ape, at what point does it become a biological human? To fully answer this question, we must first look at how our species, the *Homo sapiens* or *ben enosh* (son of man), is defined by the Torah. This article will examine what it is that makes us human despite our genetic similarity to apes and to transgenic ape-humans, how such species are viewed by *halacha*, and lastly, the biblical prohibition of *kilayim* (crossbred species).

The question of what makes humans unique has occupied the minds of philosophers, both Jewish and Gentile, since the beginning of time. Are we really that biologically different from the great apes? Recent studies show that genetically, the difference between humans and the great apes (which include chimpanzees, orangutans, and gorillas) is minimal. The approximate genetic similarity between chimpanzees and humans is 98.5% [1]. Scientists (but not *halachic* thinkers) claim that as little as five million years ago, a single creature was the common ancestor of humans, chimpanzees, and bonobos. Writes Lee Silver in his book Challenging Nature, "nonhuman organisms evolved gradually through a fuzzy evolutionary stage of partial humanness before slowly morphing into the species we call *Homo sapiens*" [2]. Some, like the authors of The Great Ape Project believe that this statistic should impact society profoundly: "we have now sufficient information about the capacities of chimpanzees, gorillas, and orangutans to make it clear that *the moral boundary we draw between us and them is indefensible*. Hence the time is ripe for extending *full moral equality* to members of other species, and the case for doing so is overwhelming" [3]. However, most humans are not quite ready to welcome chimpanzees to their homes as guests or to grant orangutans voting rights for the upcoming elections.

According to Jewish tradition, the weighty biological title of human can be placed on an individual only if and when three necessary conditions are met. The first stipulation is that the individual in question must be human-born or formed within a human; the second is that the individual must possess moral intelligence (to be discussed in further detail below); and the third is that the individual must be capable of producing offspring with another human [4]. Only one of these three conditions is necessary to be considered a human by *halacha* [4].

The earliest sources stating that humans must be formed within or born from a human are those in the *Tanach*, *Midrash*, and Talmud which refer to man as "*yelud isha*" [5], literally "one who is born from a woman." The *Chacham Tzvi* was first to derive from the language of the Talmud (*Sanhedrin* 57b) that any being formed within a woman is human and that killing such an individual would constitute murder. This view is supported by Rabbi Eleazar Fiekeles and later the *Hazon Ish* in his writing that an aberrant fetus that was miscarried is similar to a human in regard to the laws of burial and mourning [4]. Thus a human is any individual who has the characteristic of being formed within or born from a human.

What if a chimera were made of human and ape DNA? How much "human" DNA would have to be added to make a chimpanzee biologically one of us?

The second condition that defines the human race according to *halacha* is more complicated than that described above; it is the trait of *da'at* or moral intelligence. Rashi [6] (supported by *Targum Unkulus* and Rambam) wrote that humans are unique because of their ability to differentiate between good and evil, a trait not found within the animal kingdom. This is why the Seven Noahide Laws (the set of laws given to Noah as moral imperatives) were given to all of mankind. Rashi did not include IQ, intellect, or the ability to learn in his definition. Rather, he looked solely upon the trait of *sechel*, moral intelligence. Maimonides [7] and Rabbi Akiva (as quoted by *Bereishit Rabba*) included free will in their definitions of *da'at* [8]. Another possible aspect of *da'at* is that it includes speech. The ability to express oneself in as wide a vocabulary as

our own may be a distinguishing human feature [6].

The third method of gaining admission to the human race is the ability to produce human offspring with a fellow human. The Talmud in *Sanhedrin* 58a assumes that only humans can successfully reproduce with other humans. Thus, if a human offspring is born of two parents, then both parents are, by definition, human as well.

Interestingly, non-*halachic* thinkers agree with two of the three qualities to define what classifies an organism as a human being. Silver addressed the first human feature: "[t]he one biological attribute that every reader of this book shares in addition to a human brain, is biologically human parents" [2]. This claim that all humans have *Homo sapiens* parents agrees with the first *halachic* definition of humans, that humans must be formed within or born from another human.

Silver also agreed with the second definition of humans: "The ability (or potential) to speak and use symbolic language is commonly considered human-defining." Speech is one of the manifestations of *da'at*, the second human-defining quality. This argument is supported by Josie Appleton who claimed that humans evolved because of "a refinement in the vocal tract, allowing a greater range of sounds for speech." Appleton also described a moral aspect of this definition: "Humans are the measure of all things: morality starts with us" [9]. Both Silver and Appleton's explanations fall into place with different aspects of *da'at*, the second human-defining characteristic.

As to the third defining trait of humans, no scientific publication today claims that progeny of a human must be human, because this may simply not be true. Explained Silver, "Chimps and humans are so similar to each other chromosomally that most scientists believe hybrids formed between the two probably could develop and be born alive" [2]. The assumption in the Talmud *Sanhedrin* 58a that an offspring of a cross between humans and apes would not be viable is not taken at face value by Silver.

All of this bantering about what makes us human was purely theoretical for the entire history of mankind - that is, up until only a few years ago when genetic engineering accelerated into realms we never even knew existed. The first chimera (an organism which is composed of both human and animal genetic material) was an immunodeficient mouse in which human stem cells were inserted, allowing it to develop the immune system that it initially lacked.

What if a chimera were made of human and ape DNA? How much "human" DNA would have to be added to make a chimpanzee biologically one of us? Would it make a difference which human parts were formed? Let us return to the *halachic* qualifications of a human.

As to the first *halachic* human characteristic, the transgenic ape would not be human-born or formed. The animal would be born an ape, albeit it may contain some inserted human DNA or even a human organ. (Parenthetically, it is because a chimera could never be human- born that it also could never be born Jewish. Regardless of the amount of human genetic material that is added to an animal, if an organism is not born to a Jewish human mother, it cannot be Jewish.)

Would a human-ape transgenic creation achieve *da'at*, the second defining trait of humans? If human brain cells were inserted into an ape, this could be possible. Such research has scientific merit, as it would teach us about Alzheimer's, Huntington's, or brain cancer, yet it may also unintentionally give apes that spark of moral intelligence that distinguishes animals from humans. Singer portrayed an experiment in which the cerebral cortex (the part of the brain that solves problems and thinks abstractly) was increased in a chimpanzee so that it would be of a size equivalent to that of the human cerebral cortex. To accomplish this, researchers would simply increase the amount of neurons in the chimpanzee embryo. Such experiments could lessen the cranial difference between humans and the great apes [3]. (It should be noted that from a *halachic* perspective, an intelligent ape remains an ape; the *neshama* is unique to humans).

Finally, the third condition: would a transgenic ape-human be able to produce human offspring with a human? "It soon may be possible to transplant human stem cells into animal fetuses to alter their sex organs and provide them with the capacity to generate human sperm and eggs," stated Dr. John Loike and Rabbi Dr. Moshe Tendler [10]. Thus, if human genetic material was added to an embryo of a chimpanzee, the resultant organism could potentially have human gonads, enabling it to successfully mate with another human and produce human offspring. As bizarre as this may sound, such a chimera would be biologically human.

Inserting human genetic material into a member of the great ape species appears at face value to be a clear violation of the biblical prohibition of crossbreeding. The Torah commands, "You shall not let your cattle gender with a diverse kind; you shall not sow your field with mingled seed; neither shall a garment mingled of linen and woolen come upon you" [11].

Dr. Loike and Rabbi Dr. Tendler stated that, for two reasons, genetic engineering does not fall under the prohibition of crossbreeding. Firstly, the chimera's body is a "mosaic composition of cells." *Each cell has DNA of only one of the parent species.* The

biblical prohibition of crossbreeding refers to creating an animal with the DNA of *both* parents in *each* of its cells. Secondly, the Bible's motive for prohibiting crossbreeding may be inapplicable to transgenic species, since the prohibition exists primarily because offspring from such a union are sterile. Human-ape chimeras, however, may not be infertile, as explained above, thus deeming their creation permissible [10].

The very recognition of the plethora of moral questions that arise and the attempt to derive answers from ancient texts proves us to be a moral and thus human species.

In her book Brave New Judaism, Dr. Miriam Wahrman wrote about "brave new animals," or at least transgenic ones, in relation to the prohibition of *kilayim*. She cited the *Hazon Ish*'s claim that although sexual contact is forbidden between different species of animals, artificial insemination is permitted to produce a hybrid species [12]. According to this ruling, it seems that chimeras are permissible. Rav Shlomo Zalman Auerbauch, a leading *halachic* authority in Israel today, also did not consider genetic engineering to fall under the prohibition of *kilayim* [12].

A commentary on the Mishna [13] explained that, "The well-known maxim applies, a minority becomes annulled in a majority, or a major disannuls a minor quantity, or the lesser is canceled by the larger." Since in a human-ape chimera, the majority of DNA is ape DNA and the minority is human DNA, it can be inferred that the human DNA would be "annulled" or overridden since it is the minority.

Rabbi Jekutiel Judah Greenwald believed that an "engrafted or transplanted cornea becomes nullified on the recipient" [14]. He based this ruling on the Talmud that stated: "If he grafted a young shoot on an old stem, the young shoot is annulled by the old stem. The law of *orlah* (the prohibition of benefiting from a tree in the first three years after it was planted) does not apply. The young shoot does not retain its status; it acquires the status of the old tree" [15]. According to this view, any human DNA inserted in a member of the great ape species would be lost in the recipient, rendering the chimera an ape.

To summarize, various explanations for chimeras not violating the prohibition of crossbreeding include: (1) each individual cell in the chimera is only from one parental type, (2) chimeras are not necessarily sterile, (3) sexual contact between two different species need not occur, (4) genetic engineering is not considered *kilayim*, (5) a minority of genetic material is annulled in a majority (thus *halachically* rendering the chimera a pure species), and (6) the donor material becomes part of the recipient.

Despite the sources that incline *halachic* authorities to dub transgenic species acceptable, the issue of *kavod habriyot* (human sanctity) cannot be overlooked. This sanctity results from the Divine origin of our creation. Judaism considers humans to be created in the "image of God." Dr. Loike and Rabbi Dr. Tendler best defined this as: "humans beings are created as a unique species with certain obligations to partner with God in the preservation and improvement of the world." Judaism believes that God gave us dominion of the planet for us to benefit. This includes technological advances, which are permitted as long as they are used for the improvement of the world. We need not fear playing God; rather we need to fear "playing human inappropriately" [10].

According to Dr. Loike and Rabbi Dr. Tendler, "if reconstituting human brain cells in animal fetuses were to impart human-like intelligence, self awareness, and personality to the human-monkey chimera, then it would be a denigration . . . a major affront to human dignity and the sanctity of human beings" [10]. Humans were created in the image of God. To take the wisdom that God granted to our species alone and to implant it in other species is an insult to our Creator.

Interestingly, the National Academy of Sciences (NAS) agreed. In 2005, it published the "Guidelines for Human Embryonic Stem Cell Research," in which the NAS dubbed research in which human embryonic stem cells were inserted into nonhuman primate embryos as "a threat to *human dignity*" and forbade any such creations [16]. Such scientists, thereby agreeing with philosophers of Jewish thought, have recognized the value of *kavod habriyot*.

Our world is one in which the once-sharp distinction between humans and animals grows blurrier with each new scientific discovery. Heaping genetic evidence that humans are closely related to the great apes and revolutionary strides taken in genetic engineering cause many to worry that "[t]hough well equipped, we know not who we are or where we are going . . . Engineering the engineer as well as the engine, we race our train we know not where" [17]. Recent technological discoveries enable production of ape-human chimeras, a hybrid that raises many questions in *halacha*, as a topic of its own and in the realm of *kilayim*.

The very recognition of the plethora of moral questions that arise and the attempt to derive answers from ancient texts proves

us to be a moral and thus human species. Once transgenic apes begin to recognize this dilemma and similarly derive conclusions, the biologically barrier between our two species will no longer exist, for it is precisely this morality that defines a human. ■

ACKNOWLEDGEMENTS

I would like to express my sincere gratitude toward Dr. Babich for providing the sources for this essay. His enthusiasm for Torah U'Madda motivated me to develop the ideas found within this work. Additionally, I would like to thank Rabbi Eliezer Lerner of Michlelet Mevaseret Yerushalayim for his review of the Torah content. Finally, I wish to express my appreciation for my parents' constant support and encouragement.

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THE RESONANCE OF JERICHO

Kate Rosenblatt

The story of the fall of the walls of Jericho notes that the Israelites walked around the city walls, blew their horns, and roared in unison, procedures which fashioned the miraculous outcome of Jericho's fate. However, in an age without modern technology, how could a series of seemingly random and weak measures have caused the destruction of the walls of Jericho? Below is the text of the Biblical narrative in which it is clearly evident that no use of "traditional" weapons was used to invade the city – not even a bow and arrow.

"You and your marching men should march around the town once a day for six days. Seven Priests will walk ahead of the Ark, each carrying a ram's horn. On the seventh day you are to march around the town seven times with the priests blowing the horns. When you hear the priests give one long blast on the ram's horns, have all the people shout as loud as they can. Then the walls of the town will collapse" (Joshua 6: 3-5).

If we dig through the *pesukim* for evidence of some type of "weapon," we could withdraw some insight into the type of force that the Israelites used as they approached Jericho, a city having "walls that reached to the sky" (Deuteronomy 9:1). The three instructions that G-d listed for Joshua involve some sort of mechanical force (thousands of men marching around the city) and acoustic force (priests continually blowing the *shofarot* and thousands of men yelling in unison). Actually, the narrative references what very well might have been both mechanical and acoustic *resonance* [1].

In physics, resonance is the tendency of an object to oscillate at larger amplitude at preferred frequencies. These preferred frequencies are the object's resonant frequencies. Every object, no matter how flexible or stiff it may be, has a natural frequency of vibration. If a periodic series of driving forces is applied to an object, the object will eventually begin to vibrate with the frequency of the driving force instead of its own natural frequency of vibration. If the driving frequency is close to the natural frequency, then this driving frequency is a resonant frequency, and the object will vibrate with larger amplitude. The object will vibrate with smaller amplitude if the driving frequency is different from the natural frequency of vibration of the object [2].

There are various types of resonance, one type of which we have all had experience with – mechanical resonance. A common example of mechanical resonance is pushing a swing. A swing is a sort of pendulum with a natural frequency that is dependent upon the radius of the pendulum. If a series of regularly spaced pushes is applied to the swing with a frequency that matches the natural frequency of the swing, the motion of the swing, as we know from experience, will be quite large. If the frequency of the pushes is different from the natural frequency of the swing or the pushes are irregularly spaced, then the motion of the swing will not be as large and not as fun [2].

The three instructions that G-d listed for Joshua involve some sort of mechanical force (thousands of men marching around the city) and acoustic force (priests continually blowing the shofarot and thousands of men yelling in unison).

Under certain circumstances, if the frequency of the driving force is the same as the natural frequency of the object to which the force is applied, the object could vibrate at amplitude that is dangerously high. If soldiers march in lockstep over a bridge and their footsteps have a frequency equal to one of the natural frequencies of the bridge, the bridge may begin to oscillate treacherously. This is why soldiers are ordered to march in break step when crossing a bridge [2].

While the Biblical narrative of Jericho does not indicate *how* the men marched around the city, theoretically they may have marched around the city in lockstep, generating a frequency of vibration equal to the natural frequency of the walls. Thus, thousands of men marching in lockstep once a day for six days around the city walls, and seven times on the seventh day may have weakened the wall due to mechanical resonance [1].

Furthermore, the priests continually blew the *shofarot* as they marched around the city, once each day for six days. During

the seventh circle around the city on the seventh day the priests blasted the *shofarot*, and the nation shouted in unison immediately thereafter. This may have generated acoustic resonance with the city walls which had already endured a week of mechanical resonance. The acoustic resonance may have caused further vibrations resulting in the walls falling to the ground. This hypothesis may seem unlikely, but if you think about it, the destructive consequences of acoustic resonance are not so unfamiliar. If a person sings at the appropriate pitch such that the frequency of the notes being sung matches the natural frequency of a glass, the glass will vibrate and could shatter [1].

Various theories have been proposed to explain how the walls of Jericho fell down. The wording of the 20th *pasuk* in the 6th *perek* may provide a clue. "…it came to pass, when the people heard the sound of the horn that the people shouted with a great shout, and the wall fell down flat, so that the people went up into the city, every man straight before him, and they took the city." According to one theory, the words, "*every man straight before him*," suggest that not only one section of the wall shattered but that the entire wall shattered at once, similarly to the manner in which glass shatters under acoustic resonance [1].

However, this theory, which proposes that the walls shattered like glass, is not as compelling as an alternative theory which is supported by other textual clues, as well as archaeological evidence. Evidence gathered from these aforementioned sources, in fact, suggest that the earth itself vibrated at the time of the attack on Jericho. When the fate of Jericho ensued, the Biblical text uses the word "*tach'teha*" to describe how the walls fell down. "*Tach'teha*" literally means "underneath it," the subject of which is the city wall. This translation does not suggest that the walls themselves were breached, but that they sank into the earth as a result of the ground opening up beneath them. This would certainly support the earthquake theory. However, modern excavations do not show evidence of the walls having sunk into the earth, but rather that the walls fell down flat, a hypothesis which still sides with the earthquake theory. Interestingly, many Biblical translations actually do interpret "*tach'teha*" to mean that the walls fell down flat.

According to diagrams of Jericho designed by archaeologists, Jericho was fortified by a retaining wall 12-15 feet high on top of which stood an outer city wall reaching 20-26 feet above the retaining wall. Uphill from the outer city wall stood an inner city wall with similar dimensions. Even after the city walls fell down, the Israelites still had to climb over the towering retaining wall. Excavations have revealed that bricks from the fallen walls fell at the base of the retaining wall forming a ramp on which the Israelites could climb up and over. In fact, this archaeological finding matches the precise description in the Biblical text which describes how the Israelites entered Jericho: "The people *went up* into the city, every man straight before him" [3].

As a result of his excavation in Jericho in 1930-1936, Professor John Garstang emphasized that the city walls fell *outward*, such that the Israelites were able to climb over the retaining wall and up into Jericho. All archaeological sites of ancient cities in the Middle East, except for Jericho, revealed that besieged city walls fell inward simply because when invaders besiege a city they are aiming to get into the city, not out of the city. Interestingly though, Jericho's walls fell outward [4].

The Israelites did not besiege the city in the normal fashion, and thus, even had the walls fallen inward, the event would have been no less a miracle. However, the direction in which the walls fell was still an obvious convenience to the Israelites in their attack on Jericho. Was it possible for the Israelites to have caused the walls to fall in this preferred direction using resonance? Assuming that resonance caused the *walls* to shatter, it would depend on the mode of oscillation of the wall being excited by the driving force. If the walls formed a circular ring, a breathing mode of oscillation would entail radial expansion and contraction. The wall could technically break in the expansion part of the cycle or in the contraction part of the cycle, and thus, the wall could fall outward or inward respectively. However, other modes of oscillation would not result in the breaking of the wall in any preferred direction, and the wall would randomly fall in either direction. The sounds of the *shofarot* used in the attack would have had to have a frequency value much larger than the frequency of sounds within the audible range (10Hz-10kHz) since the value of the Young's modulus for stone is enormous. (The Young's modulus is a measure of how stiff an object is.) Thus, it is very unlikely that the Israelites would have been able to excite a breathing mode within the walls, and therefore, could not have made the walls fall in any preferred direction [5]. On the other hand, archaeology shows that the walls were made of baked mud [3], which may be weaker and more brittle than the kind of stone we are familiar with today. But, assuming that the walls were still too stiff to excite a breathing mode within them, the walls could still have fallen outward due to chance.

Here is another theory that is simpler and assumes that resonance caused the *earth* to vibrate. According to diagrams of Jericho that were produced based on archaeological excavations, the city was built on top of a hill, and the fortifying walls were built

around the city on the hill [3]. If this is indeed the case, then the location of the center of mass (or the center of gravity, which can be used synonymously in a uniform gravity field) would have predicted that the walls fall outward. The center of mass is the mean location of the object's total mass and can be used to explain how that object will respond to certain forces and torques [6]. If an inclined surface beneath a standing object were to shake, the object would fall in the direction in which gravity exerts the most force. On Earth, gravity would exert the most force on the side of the object where the center of mass lies. Likewise, the walls of Jericho, which stood on a vibrating inclined plane, fell outward because their centers of mass experienced the force of gravity most powerfully in the "outward direction."

Actually, excavations show evidence of earthquake activity at the time of the attack on Jericho. However, is it physically possible that the Israelites used resonance to induce an earthquake? According to the work performed by Nikola Tesla, a great Austrian inventor who lived in the 19th and 20th centuries, resonance can indeed cause vibrations in the earth like those from the effect of an earthquake. Tesla was prone to conjuring up very strange ideas, one of which materialized into an invention called the "Tesla Oscillator," also known as the "Earthquake Machine." Tesla performed his first experiments with resonance technology in his New York laboratory where he excited his little oscillating device causing vibrations in Manhattan for miles around his laboratory [7]. It follows, Tesla claimed, that by finding the most suitable frequency, *any* structure can be destroyed. Tesla once even "joked" that he could crack the earth using his device [8].

Tesla's experiment also showed that resonance waves become stronger the more distant they are from their source [7]. This explains how the Israelites were able to produce strong resonance effects while still maintaining a safe distance from the city walls so as not to be in danger when the walls would fall down. However, we should be careful not to place too much emphasis on the hypothesis regarding resonance as the cause of an earthquake at the time of the attack. It is mere speculation, but nonetheless, it raises an interesting topic for discussion.

Still, archaeological evidence and physical probabilities in addition to the Biblical text, suggest that resonance might have somehow played a role in the attack on Jericho. If the walls of Jericho indeed fell due to resonance, was the event any less of a miracle? Absolutely not – the probability of thousands of men walking in lockstep together and at the same frequency as one of the natural frequencies of vibration of the earth or the city walls (depending on which hypothesis you accept) is quite small. Furthermore, the event of all the priests blowing the *shofarot* and the thousands of men yelling at the same frequency as one of the natural frequencies of vibration of the earth or the walls is also a small probability occurrence. Thus, even had the walls fallen due to resonance, the event is no less a miracle. And, although the event is considered a miracle, it does not necessarily follow that it occurred contrarily to the laws of nature. ■

ACKNOWLEDGEMENTS

Dr. Babich, I am grateful that you introduced me to *Derech Hateva* two years ago when I was a freshman. Each year since then I have looked forward to submitting a paper for this journal. I also thank you and this year's journal editors for the time you took to carefully review this paper. Dr. Santos and Dr. Frenkel, I appreciate your patience and the valuable feedback you gave me on the questions I had about physics. Thank you, Rabbi A. Cohen, for kindly reviewing the Torah content of this paper. Max, thank you for helping me select this intriguing topic. And finally, Mom and Dad, my sincerest thanks go to you for sending me to Stern College where I can achieve my intellectual and academic pursuits.

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THE POMEGRANATE: BEAUTY AND HEALTH IN ANCIENT AND MODERN TIMES

Malki Silverman

The ancient fruit *Punica granatum,* better known as the pomegranate, is thought to have first been cultivated in the Middle-East nearly 5,000 years ago. Archaeologists have been able to place its origin in southwestern Asia, 3000-2000 BCE, where fragments of pomegranate have been recovered in the caves of the Judean Deserts and in the wadis near Ein Gedi [1].

Throughout the Biblical period (1200-445 BCE), the pomegranate was seen as symbol of the Hebrews. This comes to no surprise since the pomegranate appears as a representative sign for many important aspects throughout our *Tanach* and Talmud. According to Rabbinic tradition, the pomegranate has exactly 613 seeds, corresponding to the 613 *mitzvot.* Although not every pomegranate has 613 seeds as the tradition connotes, in many cultures, the pomegranate has long been seen as a symbol of fertility, due to its large number of seeds [2]. Throughout *Tanach,* the pomegranate is seen as a special fruit, symbolizing health and beauty. Pomegranates were placed as decorations on the clothes of the *Kohanim* (Exodus 39:24-26) and as ornaments for the pillars of the *Beis Hamikdash* (Kings I 7:18). The pomegranate was among the fruits that the spies brought back from Israel (Numbers 13:23), symbolizing the greatness of the land. In Song of Songs (6:7), the pomegranate is an icon of beauty as it is written, "As a piece of pomegranate are thy temples…" Pomegranates are also among the fruits liable for the agricultural *mitzvot* of *Peah* (*Mishna Peah* 1:5) and *Ma'aser,* (*Mishna Maasarot 1*:2) as well as *Orla* and *Shmita* (*Mishna Shvi'it* 7:3) [1]. Most importantly, in Deuteronomy (8:8), the pomegranate is listed as one of the *Sheva Minim.* This designation seems to have been given because of its beauty, since the pomegranate was not an integral part of people's diet at the time like the other six species.

With its status as one of the *Sheva Minim,* the pomegranate is inherently distinctive. Pomegranates can be brought to the temple as one of the first fruit offerings, and eating a pomegranate requires the special *bracha achrona* of *Me'ein Shalosh*. However, the pomegranate has additional attributes which contribute to its uniqueness. Already in Ancient Egyptian times, pomegranates were thought to have medical health benefits. The rind of the fruit was used as a remedy for tapeworm and other intestinal illnesses [1], and the peels were commonly used to form dyes. This method was utilized by our ancestors as well, as evidenced in *Mishna Shabbat* (9:5), "pomegranate peels… enough to dye with them a small garment in a headdress." The pomegranate is an integral part of Ayurvedic medicine, a traditional form of Indian medicine, where it is used for stomach illnesses as well as a treatment for leprosy [3]. Although it has been traditionally recognized, with the availability of new technology and experiments, scientists have only recently been able to unlock the pomegranate's true medical potential.

It is interesting that one of the first fruits to be examined for these unique health benefits is also one of our Sheva Minim.

Pomegranates contain many different chemical compounds such as aldehydes, linear-hydrocarbons, and alcohols, which give the pomegranate numerous health benefits [2]. It has been discovered that pomegranates, due to their high content of polyphenols, have high antioxidant activity, a factor which can reduce the risks of cardiovascular disease and cancer. Phenols are organic compounds containing a six-membered aromatic ring, directly connected to a hydroxyl group (-OH). Polyphenols are therefore capable of antioxidant activity because of their ability to lose the hydrogens of their hydroxyl groups, thereby becoming oxidized and acting as reducing agents. This property allows the polyphenols to neutralize free radicals produced during mitochondrial oxidation reactions, thus protecting cells from a high free-radical content that has been associated with cancer. The most common polyphenols found in pomegranates are anthocyanins, catechins, ellagic tannins, and gallic/ellagic acids [2]. The antioxidant behavior of pomegranates is mostly due to the high content of hydrolysable tannins. Punicic acid, the main constituent of the pomegranate seed, has the ability to induce apoptosis and inhibit cell growth in cancer cells [4]. Pomegranate juice has also been shown to reduce the progression of atherosclerosis [5].

Recent *in vitro* studies administering pomegranate extract at different concentrations to normal and cancerous cells have shown additional chemical activity of the pomegranate, namely its ability to also act as a prooxidant. The antiproliferative mechanisms of pomegranate extract to cancer cells is additionally caused by the induction of oxidative stress through the generation of hydrogen peroxide. This behavior marks pomegranate extract as an important prooxidant as well as an antioxidant, in regards to its actions towards cancer cells [6]. A unique aspect of the prooxidant behavior of pomegranate extract is that it preferentially targets and kills the cancer cells. Cancer cells, because of their deficient antioxidant defense systems, are hypersensitive to oxidative stress, whereas normal healthy cells, with their fine-tuned antioxidant defense systems are left unharmed. Apparently, the pomegranate is an exceptional nutraceutical, a food that is nutritious and can be used medicinally.

The chemicals found in pomegranates responsible for the medical processes mentioned above can also be found in green and black teas, as well as other types of plant-derived foods. Studies of nutraceuticals provide are an extremely interesting and potentially inexpensive way of preventing harmful diseases. It is interesting that one of the first fruits to be examined for these unique health benefits is also one of our *Sheva Minim.* Although we, as Jews, pray to G-d for *refuah*, we still understand the importance of putting in our own *hishtadlut,* our own efforts. The secrets of the pomegranate demonstrate that the Torah is an excellent first step in our research. ■

ACKNOWLEDGEMENTS

I would like to firstly thank Dr. Babich for his help with my research and writing of this article, and for always pushing me in the right direction. Without his continuous guidance and assistance in all my endeavors, my years in Stern would not have been the same. I would also like to thank my parents for their never-ending support and motivation throughout all of my education.

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HALAKHIC HEADACHES: HOW MUCH AFFLICTION IS TOO MUCH?

Rose Snyder

As scientific and technological developments continue to be made, many people argue that the expanded power of scientists may cause them to "play G-d" as they manipulate natural processes. G-d commanded the Jews to fast on the holiest day of the year. Yom Kippur, which literally means Day of Atonement, is the day on which G-d forgives the individual for her past sins and seals her fate for the coming year. Those who repent will be forgiven, so the day is spent in prayer and is the most widely practiced fast day in Judaism. The commandment to fast on this day is noted in Scripture: "On the tenth day of this month it is the Day of Atonement; there shall be a holy convocation for you, and you shall afflict your souls" (Leviticus 23:27). The underlying principle of afflicting the soul is that avoiding physical pleasures - including eating and drinking - will help the individual focus instead on her spiritual state and reach inner purification [1]. A common side effect of this 25-hour fast is development of a headache which has been shown to occur in 40% of Jews observing the fast. Although the exact physiological basis for this type of headache is unknown, possible causes and treatments have been studied and tested. Many Rabbis have agreed that studying the physiological effects of 25-hour fasts with the intention of testing and developing methods for relieving excessive discomfort does not interfere with the Divine commandment to "afflict your souls" [2]. Instead it will enable fasters to better concentrate on repenting and encourage more people to undertake the fast.

Developing effective methods for preventing this type of headache - commonly called the Yom Kippur headache - must follow an understanding of the physiological basis for the headache. A fasting headache has been identified as a secondary headache, one which is caused by an underlying condition, and is attributed to a disorder of homeostasis. The patient must have fasted for more than 16 hours, develop it during fasting, and it must be resolved within 72 hours after food consumption. It must also have at least one of the following characteristics: frontal location, diffuse pain, nonpulsating quality, and mild or moderate intensity. The Yom Kippur headache was first identified as a fasting headache in the 1994 study by Mosek *et al.* who studied the prevalence of headache on 211 subjects who observed the Yom Kippur fast. The headaches of the subjects were characterized by the same features that characterize fasting headaches. Mosek *et al.* also found that subjects with a history of headache are more likely to develop the Yom Kippur headache and that the frequency of headache attacks increases with the duration of the fast [3].

Therefore, to maximize the amount of glycogen stored in the muscles, many recommend loading up on carbohydrates a few days before Yom Kippur. This is similar to what runners do before a marathon.

Later studies by the same and other scientists have helped elucidate the basis for the Yom Kippur headache, although much remains to be understood. In 1999 Mosek *et al.* investigated dehydration as a possible cause for the Yom Kippur headache. Because weight loss during the fast is mainly a result of dehydration, they were able to compare the average weight loss of their subjects and the prevalence of headache. However, the findings found no correlation between weight loss and headache and therefore ruled out dehydration as a cause for the Yom Kippur headache [4]. Interestingly, also in 1999 Awada *et al.* studied headache during the first day of Ramadan. The clinical features of the first-of-Ramadan headache (FRH) were found to be similar to those of the Yom Kippur headache. The observation that the frequency of headache increased with the duration of the fast and that those with a past history of headache were more likely to develop fasting headache confirmed the findings of Mosek *et al.* However, some of their findings differed significantly. Awada *et al.* found that water intake led to the disappearance of headache in some of their subjects, which showed a correlation between dehydration and headache. They also found that tea or coffee consumption resolved the headache in over half of the subjects, whereas Mosek *et al.* had found no correlation between coffee/tea consumption and headache [3].

Based on these findings, possible mechanisms and treatments for the Yom Kippur headache have been proposed. A common cause for migraine-like symptoms - including headache - is caffeine withdrawal. Fasting has therefore been identified as a possible cause for the caffeine-withdrawal headache. This correlation was demonstrated by Nikolajsen, who found that patients who consumed more than 400 mg/day of caffeine were more likely to develop headache during preoperative fasting [3]. While these findings support those of Awada *et al*., they are not supported by the findings of Mosek *et al.,* who found no correlation between coffee/tea consumption and the prevalence of the Yom Kippur headache. Despite this discrepancy, many people suggest cutting down on the amount of caffeinated beverages consumed the week before the fast [5].

Another attempt to relieve the discomfort of the Yom Kippur headache employed an anti-inflammatory pain-relief drug. Rofecoxib (also known as Vioxx®) inhibits Cox-2, an enzyme that causes pain and inflammation, and it has a long plasma half-life, allowing for continued drug activity. In a 2004 study, Drescher *et al*. investigated the effects of Rofecoxib on the Yom Kippur headache and found that only 18.9% of subjects who received the drug reported a headache at some point during the fast, while 65.4% of the subjects who received the placebo reported a headache [2]. However, also in 2004 Vioxx was taken off the market because its long-term, high-dosage use was reported to cause an increased risk of heart attack and stroke [6]. Drescher conducted a similar study on the 2008 Yom Kippur. This time he used etoricoxib, which also has a long plasma half-life and has pharmacological properties similar to rofecoxib. Again, he found a decreased rate of headache in the group that received the drug and concluded that the drug effectively decreases the likelihood of developing the Yom Kippur headache [7].

While studying the causes and treatments for the Yom Kippur headache helps relieve excessive discomfort, another approach to relieving unnecessary pain comes from studying the dietary composition of the pre-fast meal and its effects on fasters. Blondheim *et al*. investigated this correlation in a study where different pre-fast meals were given to the test subjects. While the meals were equicaloric and contained equal amounts of sodium and water, they differed in their main source of calories - fats, carbohydrates, or protein. Each subject was tested with each of the pre-fast meals. They were evaluated by their degree of hunger and thirst throughout the fast, as well as their subjective discomfort during each experimental fast as compared to the discomfort usually experienced during religious fasts. The subjects reported significantly higher levels of discomfort after the protein-rich pre-fast meal than after the carbohydrate-rich and fat-rich meals. Additionally, there tended to be higher rates of thirst after the protein-rich meal. Based on their findings, Blondheim *et al* concluded that a protein-poor pre-fast meal is likely to bring easier fasting [8].

Some nutritionists also recommend eating increased amounts of carbohydrates for a few days before Yom Kippur [9]. On a normal day, the human body relies on the ingested carbohydrates to fuel its metabolic activities, especially brain metabolism [3]. However, on a fast day the body must rely on the glucose stored in the liver, in the form of glycogen, as its source for energy. While liver glycogen provides about three quarters of the necessary glucose, the remainder is from the additional glycogen stored in the muscles. Therefore, to maximize the amount of glycogen stored in the muscles, many recommend loading up on carbohydrates a few days before Yom Kippur. This is similar to what runners do before a marathon [9].

Interestingly, glucose levels might also be related to the Yom Kippur headache. In addition to caffeine withdrawal, another proposed mechanism for the Yom Kippur headache is hypoglycemia. Reduced blood glucose levels are generally thought to trigger or worsen migraine attacks. However, other scientific evidence does not support this hypothesis. For example, studies have shown that insulin-induced hypoglycemia does not cause headache attacks in migraineurs. The exact physiological cause for the Yom Kippur headache is unclear. Scientists suggest that the psychological strain of fasting and change in daily habits might cause a headache attack, especially in predisposed individuals [3]. One can imagine that the stress of Yom Kippur, when man stands in judgment before G-d, would especially contribute to this psychological strain.

Scientific investigation and experimentation have led to a deeper understanding of the Yom Kippur headache and of the dietary regulations that could help alleviate excessive discomfort on Yom Kippur. Although the underlying cause for the Yom Kippur headache is still unclear, the study conducted by Drescher *et al*. in 2008 demonstrated that etoricoxib decreased the prevalence of Yom Kippur headache. They received approval from Rabbis to conduct the study because the drug treatment does not interfere with the commandment "to afflict your souls." While the drug might alleviate headache pain, it does not remove all effects of hunger and the faster will still experience the affliction that is described in Scripture [6]. While there seems to be no *halakhic* issue with developing such treatments, some individuals have expressed

the sentiment that trying to manipulate the dietary composition of the pre-fast meal to make the fast easier contradicts the spiritual goal of Yom Kippur - to use affliction to reach inner purification [1]. They might feel that using scientific experimentation to manipulate the natural effects of fasting resembles the idea of "playing G-d." However, most people believe that relieving excessive discomfort is justified because it allows the faster to better concentrate on repenting for past sins. Rav Soloveitchik, in many of his writings, emphasized the creative power of man: "When G-d bestows wealth, property, influence, and honor, the recipient must know… how to turn these precious gifts into fruitful, creative powers" [10]. By using the developments of modern science to better understand the physiological effects of fasting, man - rather than "playing G-d"- uses his creative powers to enhance his service of G-d. ■

ACKNOWLEDGEMENTS

Thank you to my parents for supporting my education and always encouraging me to accomplish my goals. A huge thank you also goes to Dr. Babich for helping me with the topic of this paper and providing me with sources.

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MA'ASEH AVOT SIMAN L'BANIM: SPIRITUAL AND BIOLOGICAL PARALLELS

Helen Ayala Unger

The idea that people's actions create a paradigm for their offspring's lives is a popular concept in rabbinic writings. This concept, called *maaseh avot siman l'banim* (the deeds of the fathers are a sign for their children), manifests itself in several places in the Torah, stressing that the actions and spiritual nature of the Biblical forefathers have paved a path for Jews in later generations. This theory originated with *Chazal* and is referenced by many central Torah commentators. For example, Nachmanides, a 13th-century commentator from Spain, cited Abraham's journey from the land of Israel to Egypt as a precedent for his children's later exile to Egypt; in addition, he noted that Abraham left Egypt laden with gifts, as did the Children of Israel when they were freed from their Egyptian bondage [1]. The *Ruach Chaim*, another commentator, noted that in the fourth *mishnah* of the fifth chapter of *Pirkei Avot*, which describes ten tests that Abraham passed during his lifetime, the phrase "*Avraham Avinu*" (Abraham our father) is emphasized because Abraham's ability to overcome challenges was instilled in his offspring's spiritual DNA for generations [2].

Chazal clearly state that the deeds of our ancestors—their acts of kindness and dynamic decisions—have impacted the lives of their offspring and created a paradigm for Jewish history. The burgeoning field of epigenetics provides biological evidence that the actions and habits of ancestors impact their descendents in surprising and sometimes alarming ways. Epigenetics, a field of biology which studies alterations in gene expression unrelated to the DNA sequence, has identified several phenomena that can lead to either increased or decreased gene expression in individuals. One such phenomenon is DNA methylation, in which a methyl group attaches to either the 5-position cytosine pyrimidine ring or the 6-position adenine purine ring in DNA by way of DNA methyltransferase [3]. This commonly occurs during gametogenesis in humans, during which genomic imprinting takes place. Methylated DNA becomes hypercondensed and thus unable to be transcribed; in women, for example, the Prader-Willi gene is imprinted by methylation and becomes nonfunctional, allowing for monoallelic paternal expression. Studies have demonstrated that cancers, such as prostate carcinomas, can be caused by aberrant hypermethylation of tumor suppressor genes and DNA repair genes, causing the affected cells to become tumorigenic [4]. DNA methylation is the most common form of epigenetic regulation, and is currently the subject of cutting-edge biological research.

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Another common epigenetic phenomenon is histone acetylation, in which an acetyl functional group is added to the *N*-terminus of the histone proteins that allow DNA to condense into chromatin. Normally, histone complexes have a positive net charge, allowing them to associate with negatively-charged DNA molecules. The addition of the acetyl group neutralizes that positive charge, causing the DNA to loosen from the histone complex; in the end, this allows the DNA to be transcribed. Acetylation is also associated with genetic alterations related to cancer. A 1997 study showed that the expression of the tumor suppressor gene p53 could be regulated by histone acetylation both *in vitro* and *in vivo* [5]. Additional studies have demonstrated that DNA methylation and histone acetylation may work cooperatively, and evidence that the two phenomena influence each other in living cells is accumulating [6].

Modern research indicates that the epigenetic regulation of genes in individuals can be influenced by the actions of their parents, both before conception and during pregnancy. A study done in 2000 showed that after altering the diet of female agouti mice (which carry a dominant gene providing susceptibility to obesity, diabetes, and cancer), their offspring developed into normal-weighted and healthy mice. The mother mice were fed a diet rich in methyl donors; thus, the production of normal offspring has been attributed to the methlyation of the agouti gene during em-

bryonic development [7,8]. Another study found that when mice with genetically-induced memory deficiency were allowed to live in an environment filled with exercise, attention, and other mental stimulants, they produced offspring who—while carrying the deleterious gene—showed great improvement in their long-term memory function, even when raised in environments without extra attention [8].

In humans, it has been found in numerous studies that women who are pregnant when stress levels are high, such as during wartime or disease epidemics, have a greater chance of producing children affected by schizophrenia than women pregnant during peaceful times [9-11]. It is thought that the cause behind this trend is an epigenetic alteration impairing proper neural development [9]. In addition, the methylation of genes involved in immune system development has been identified as a cause of asthma and allergies; this hypermethylation is brought on *in utero* by environmental factors, such as cigarette smoke and dietary nutrient supply [12, 13]. It has also been found that low dietary levels of folic acid, methionine, and choline can promote aberrant genome methylation patterns at all stages in life, but is most damaging during fetal development. The effect of diet upon the epigenome manifests itself mainly in the promotion of cancers, such as those of the stomach, head, and neck. [14]. It is clear that the choices that parents make have a tangible impact upon the health and well-being of their children.

Ultimately, of what significance are these findings to the average person? They serve, mainly, to emphasize the importance of living a healthy lifestyle and ensuring one's well-being by eating a balanced diet and avoiding toxins such as cigarette smoke and polluted air. These studies are particularly vital for women who are pregnant or plan to become pregnant, since it has been found that many epigenetic events take place during fetal development and are caused by the mother's choices. Current research has revealed an intriguing biological parallel to *Chazal*'s spiritual concept. Thus, just as our forefathers strove to become spiritual giants, we must put forth great effort towards maintaining our health, for it has become clear that our actions do not merely impact us personally. Just as Abraham set the tone for his children when he went down to Egypt, we too set the tone for the health of generations to come by the choices we make today. ■

ACKNOWLEDGEMENTS

First, I would like to thank my parents for their continuous support of my academic and Judaic growth. I thank Dr. Babich for all that he does for the student body of Stern College and his review of the scientific content of this article. I would also like to thank Rabbi Yehuda Willig of Yeshiva University for reviewing the Torah content of this article.

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PLAGUES 4 TO 6: WILD ANIMALS, PESTILENCE, AND BOILS

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The Ibn Ezra (*Shemos* 9:1) noted that the plagues of blood and frogs were mediated through the medium of water, of lice and wild animals through the medium of soil, and of pestilence and boils through the medium of the atmosphere. Plagues 4, 5, and 6, or, those afflictions caused by swarms of wild animals, microbial pestilence, and skin boils, are the subjects of this article.

Plague #4

"*HaShem* said to Moshe: Arise early in the morning and station yourself before Pharaoh - behold, he goes out to the water - and you shall say to him, So said *HaShem*: Send out My people that they may serve Me. For if you do not send out My people, behold, I shall incite against you, your servants, your people, and your houses, the swarm of wild animals; and the houses of Egypt shall be filled with the swarm, even the ground upon which they are" (*Shemos* 8:16, 17). A disordered assortment (Rashi) of roving (Ramban) animals, from the wilderness [1], invaded Egypt. Some of the species of animals were foreign to Egyptian soil (*Haamek Davar*) and fear of these unfamiliar creatures terrified the Egyptians. Undoubtedly, this assortment of animals included many species that, among themselves, were predator-prey associations, e.g., wild goats and lions. Yet, these species intermingled in harmony, without the stronger species (the predators) attacking the weaker species (the prey) [2]. Rav Avigdor Miller [3] connected this plague to the prior plagues of blood and lice. "Packs of rabid animals descended upon the towns, probably maddened by the foul water of the first plague and the harassment caused by the lice and ticks of the third plague."

Peoples in the lands surrounding Egypt stood dumbfounded as hordes of wild animals stampeded from their natural environs towards Egypt. There is a thought that *HaShem* put out a worldwide call, commanding animals throughout the world to stampede towards Egypt [2, 4, 5]. If so, Eskimos may have stood in awe and in utter confusion as they watched polar bears dive into the frigid waters and swim towards Egypt.

Many commentators suggested that *HaShem* changed the inherent nature of these animals, causing them to uncharacteristically leave their natural forests, jungles, plains, and deserts and to invade areas populated by human beings. The mixture of wild animals was not a new creation; the novelty of this plague was that the animals, normally denizens of forests and jungles, now invaded man's habitat, something that was very untypical of their behaviors (Rabbeinu Bachya).

In the plague of wild animals, HaShem removed the instinct of wariness, thereby providing the animals with the courage to freely attack and harm human beings.

Since the time of Noach, *HaShem* implanted into the psyche of wild animals a degree of timidity towards human beings. During the year aboard the ark, Noach and his sons catered both day and night to the physical needs of the various species of animals. The animals, now accustomed to human beings, no longer feared them [6]. To assure the safety of Noach and his family upon their leaving the ark, *HaShem* said, "The fear of you and the dread of you shall be upon every beast of the earth and upon every bird of the heavens, in everything that moves on earth and in all the fish of the sea; in your hand they are given" (*Bereshis* 9:2). *HaShem* implanted in animals an instinctive fear or "wariness" of human beings (Abarbanal). Animal "wariness" describes their cautiousness and watchfulness of human beings; always on the alert to avoid risk. Animal wariness is their response to being preyed upon by hunters and to depletion of their natural habitats by human activities. Essentially, it is their inherent protective measure against annihilation. In the plague of wild animals, *HaShem* removed the instinct of wariness, thereby providing the animals with the courage to freely attack and harm human beings (Alshich; Rashi) [1].

A logical assumption is that upon seeing the swarms of invading wild animals the Egyptians quickly bolted the doors and closed the windows of their homes. If so, how did the wild animals gain entry into the Egyptian homes? This question apparently bothered various commentators. One thought is that huge aquatic creatures emerged from the ocean depths, entered Egypt, crawled over the Egyptian houses and, using their massively long

arms, tore off the roofs, doors, and windows (*Sefer HaYashar*). Note, in the Hebrew edition of *Me'Am Loez* the term for this aquatic creature is "*silonis*," which, in the English edition translated by Rav Aryeh Kaplan [5], was described as a giant octopus or a giant squid. Until recently, the existence of these creatures was known only from their large tentacles that occasionally washed upon shore or from dead specimens caught by commercial fishing boats. However, in 2004, Japanese scientists photographed the first images of a live large squid (*Architeuthis*), roughly 25 feet in length, at a depth of 2,950 feet beneath the north Pacific Ocean. These large creatures were found to be active predators, with sperm whales as their diet [7]. Giant octopuses have also been identified in the Pacific Ocean. The world's record giant octopus (*Enteroctopus dolfleini*) weighed live at 156.5 lb, with a length of 23 feet [8]. Another thought was that *HaShem* agitated the ocean currents, igniting giant waves to smash against the doors of the Egyptian houses, thereby opening the houses for entry by the wild animals [2]. The tsunami of 2004, in which >300,000 people perished, exemplifies the force of ocean waves.

Other commentators focused on the end of the *pasuk* 17, "even the ground upon which they are." Ibn Ezra suggested that "ground" included "deserts," as swarms of animals invaded both the inhabited and uninhabited areas of Egypt. Others (S'forno; *HaKetav Vehakabbalah*) suggested that "ground" referred to burrowing animals, e.g., amphibians, reptiles, snakes, insects, spiders, and worms, which invaded the Egyptian homes by burrowing through the soil. Even in their locked houses, the Egyptians felt insecure.

Another thought is that "even the ground upon which they are" referred to a specific creature, the *adnei hasadeh*. There are four distinct suggestions to identity the *adnei hasadeh*: (1) a creature intimately attached to the ground (G'ra in *Kol Eliahu*; *Tosfos B'racha*); (2) a human; (3) a humanoid; or (4) a primate. The *adnei hasadeh* is introduced in *Kilayim* (8:5), when discussing whether touching a corpse of the *adnei hasadeh* confers the same impurity as touching a human corpse. According to Rav, the *adnei hasadeh* is a ferocious animal, human-like in appearance, attached to the ground by a ("an umbilical?") cord, through which it obtains its sustenance from the soil. Hence, for this creature to migrate to Egypt, the connecting cord and ground must accompany it. The Artscroll edition of *Kilayim* expanded the discussion on the *adnei hasadeh* noting that its movements were limited to the radius of the cord, that it was extremely dangerous and killed anything within its circle of movement, and that its life depended on the cord's connection remaining intact to the ground. To kill this creature, hunters would stand outside the creature's radius of movement and shoot at the cord, which upon being severed, the *adnei hasadeh* emitted a loud groan and died.

The other suggestions of the identity of the *adnei hasadeh* eliminate its cord attachment to the ground. In the Mishnah cited above, Rav Yosi assumed that the *adnei hasadeh* had the status of a human being. The Talmud Yerushalmi, *Kilayim* (8:4) described the *adnei hasadeh* as a "mountain man." Aruch considered the *adnei hasadeh* either as a feral human who grew up in the jungle or as a species of wild human. Rav Shimon Schwab [9] considered the *adnei hasadeh* to be "man-like creatures with some intelligence who were able to cultivate fields, hence their name." He further explained that they were "most likely identical with the so-called "prehistoric men" which in spite of their similarity to men, were not created in the image of G-d and not endowed with a Divine soul. Nevertheless, they were capable of cultivating the soil, building settlements, fashioning all kinds of artifacts, and even drawing pictures inside the caves where they lived." Other identities of the *adnei hasadeh* included those of various primates (Rav Phinchus Kahati; Malbim and *Sifra* on *Vayikra* 11:27), including the orangutan (*Tifereth Yisroel* (see Boaz)) and the chimpanzee (Rambam in *Perush HaMishnayos* to *Kilayim* 8:5, specifying a primate that chattered incessantly without interruption).

HaShem continued the narrative: "And on that day I shall set apart the land of Goshen upon which My people stand, that there shall be no swarm there; so that you will know that I am *HaShem* in the midst of the land. I shall make a distinction between My people and your people - tomorrow this sign will come about" (*Shemos* 8:18, 19). For the prior two plagues, frogs and lice, no specific mention was made to distinguish between Goshen and Egyptian land. Several commentators (*P'nei Rosa*; Rabbeinu Bachya; Ramban; Rashbam) suggested that the mixture of wild animals was different from the frogs and lice, whose mobility was limited. The greater mobility of the wild animals and their nature to freely roam from area to area necessitated a specific statement that a distinction will be seen between Egyptian and Jew.

"HaShem did so and a severe swarm of wild animals came to the house of Pharaoh and the house of his servants; and throughout the land of Egypt; the land was being ruined because of the swarm" (*Shemos* 8:20). How did the animals ruin the land? One thought was that defecations from the alien species of animals polluted the Egyptian soil (Abarbanel; *Me'Am Lo'ez*).

Eventually, Pharaoh had his fill of this plague and (insincerely) relented to Moshe's demand. "Pharaoh summoned Moshe and Aaron and said, "Go! Sacrifice to your G-d in the land" (*Shemos*

8:21). In a few sentences further, *HaShem* caused the animals to leave Egypt. "Moses left Pharaoh's presence and prayed to G-d. *HaShem* did as Moshe requested and He removed the wild animals from Pharaoh, his servants, and his people. Not a single one remained" (*Shemos* 8: 26, 27). Many commentators contrast the removal of the frogs with that of the wild animals. When the frogs died, "they piled them up into heaps and heaps and the land stank" (*Shemos* 8:10). The animals did not die, but left and returned to their original habitats. If they had died, the Egyptians would have profited from their valuable hides and furs (*Me'Am Lo'ez*) and from their use as food (Rabbeinu Bachya). The Rosh (as translated by Rav Munk [10]) noted that the wild animals did not reproduce during their invasion of Egypt. They returned to their natural habitats, in numbers equivalent to those that left, and, thus, they did not adversely affect the carrying capacities of their natural environments. The carrying capacity, or the maximum population size that an ecosystem can support indefinitely, is determined by the sustained availability of two resources: (a) renewable resources (e.g., water, light, nutrients) which are replenished by natural processes and (b) nonrenewable resources, such as space [11]. If the animals had reproduced, coupled with the suspension of predator-prey relationships, the larger numbers of animals returning to their natural ecosystems would possibly have overwhelmed the carrying capacities of their various ecosystems.

Plague #5

Pestilence, the fifth plague, potentially is any virulent, highly contagious infectious disease that can reach epidemic or even pandemic proportions. Such diseases could be of microbial (e.g., bacterium, fungus, or parasite) or of viral (e.g., swine flu) origin. The highly contagious nature of such diseases was recognized, as noted in *Bava Kama* (60b), "If a pestilence is in the town, gather in the feet," meaning that people would lock themselves in their homes to avoid contact with others.

The destruction of the Egyptian economy, principally that component mediated by livestock and transport animals (Alshich), was the focus of the fifth plague. Agricultural field work was dependent on oxen for plowing, terrestrial transport of materials was accomplished with donkeys (for domestic commerce) and with camels (for foreign commerce), military strength and operations through chariots drawn by war horses, and food and clothing was obtained from sheep, goats, and cows. The fifth plague abruptly crippled the Egyptian economy and greatly lessened the international importance of Egypt as the center of commerce in the Middle East [1, 12].

There is some disagreement among the commentators as to the extent of the epidemic, whether it affected only those animals in the fields or also affected those animals that were housed indoors. The *pasuk* (*Shemos* 9:2) stated "For if you (i.e., Pharaoh) refuse to send out and you continue to grip them (referring to *B'nei Yisrael*), behold, the hand of *HaShem* is on your livestock that are in the field, on the horses, on the donkeys, on the camels, on the cattle, and on the flock - a very severe epidemic." According to Rashi (9:10), only those animals in the field were killed, whereas according to Ramban (9:1), the plaque extended to those livestock housed indoors. Ramban, as well as Rabbeinu Bachya and Sifsei Cohen, further noted that pestilence is usually associated with harmful changes in air quality (i.e., in the terminology of today, "airborne transmission" of disease-causing microbes or viruses). Thus, it would be expected that the disease also affected livestock housed indoors.

According to this theory, the skin lesions were caused by radioactive fallout.

The description of the plague continues (*Shemos* 9:4), "*HaShem* shall distinguish between the livestock of Israel and the livestock of Egypt, and not a thing that belongs to the Children of Israel will die." According to Ramban, Rabbeinu Bachya, and Sifsei Cohen (see *Me'Am Lo'ez*), because of Egyptian abhorrence of shepherds (*Bereshis* 46:34), the Egyptian-owned flocks were pastured very far from their cities. Rather, they were pastured in fields bordering Goshen. Undoubtedly, Egyptian-owned and Jewish-owned flocks intermingled and yet, albeit pastured side-to-side, the contagion spread only to the Egyptian-owned sheep. Airborne transmission of this plague was recognized (Ramban; Rabbeinu Bachya, and Sifsei Cohen) and the miracle was further compounded by the lack of death of these Jewish-owned sheep. Although not explicitly mentioned in the *chumash*, the death of thousands upon thousands of livestock in Egyptian soil must have caused an unimaginable stench across the entire country, similar to that caused by the rotting fish in the first plaque and the rotting piles of decaying frogs in the second plague [13].

Rabbi Eliyahu Munk [10, 14] in his translations of the Tur and Rabbeinu Bachya, specifically noted that the plaque of pestilence was caused by an unspecified airborne microbe. It is interesting to postulate on the identity of this microorganism. Although many microbes are potential candidates, my colleague, Dr. Jennifer Suss (SCW graduate and noted veterinarian practicing in New Jersey)

suggested *Bacillus anthracis*, the causative agent of anthrax, as the bacterial tool used by *HaShem* to generate the fifth plague. Interestingly, this bacterium is the microbial agent of choice by those involved in bioterrorism; in 2002, the strange white powder placed in sealed envelopes generated much excitement and stress in the United States. This bacterium occurs in two physiological states, (a) a growing vegetative cell and (b) a dormant endospore. The vegetative state is the actively growing, reproducing form that causes the disease. In infected cattle, the course of the disease is short, with death occurring one to three days post-infection. Symptoms of cattle anthrax include fever, cessation of rumination, excitement followed by depression, uncoordinated movements, respiratory difficulty, convulsions, bloody discharges from natural body orifices, and finally death. After death, if the carcass is opened for necropsy by a veterinarian, for food by a carrion-feeding animal, or through decay, the vegetative bacteria are exposed to air and quickly sporulate to form endospores. *B. anthracis* endospores are resistant to environmental stresses, remain viable, albeit inactive, for years, and are the form in which the disease is transmitted. When endospores enter another animal, either through airborne transmission or through grazing on contaminated vegetation, the endospores germinate to their vegetative forms and initiate the diseased state [15].

Plague #6

The sixth plague was skin boils and blisters (*Shemos* 9:8-12). *HaShem* commanded Moshe and Aaron to fill both their hands with furnace soot. Aaron and Moshe then transferred all four handfuls into one of Moshe's hands, which miraculously held all the furnace soot. Holding the four handfuls in one hand, Moshe forcefully hurled it heavenward before the eyes of Pharaoh. The Middle East is, at times, in inundated with hot southerly winds coming from the Sahara (*khamsins)* carrying ultrasmall particles of sand at a density significant enough to eclipse the sun. Perhaps, Moshe's hurling the soot heavenward needed to be done in front of Pharaoh, so that Pharaoh could not attribute this plague to a natural sandstorm (S'forno). The relatively small amount of furnace soot hurled upward spread over the entirety of Egypt, rained down as soot, and caused painful skin boils and blisters to erupt both on human beings and on livestock. The Tur [10], as well as the Ramban, suggested that winds carried the soot into the Egyptian homes, thereby afflicting those who remained indoors.

In describing the curses to befall *B'nei Yisrael* should they not observe the commandments, it is written, "*HaShem* will strike you with the boils of Egypt, with *garav* and with *cheres*, of which you cannot be cured (*Devarim* 28:27). According to Rashi, *garav* is an affliction of moist boils and *cheres* is an affliction of dry boils. Rav Munk [16] suggested that the skin boils of the sixth plaque were curable, either because they were supernatural (*Tosafos* to *Bechoros* 41a) or because they were of a different type (Maharsha) than mentioned in *Devarim*. Rav Sorotzkin [2], however, maintained that the boils of the sixth plague were incurable. Another thought is that the incurability of the skin boils noted in *Devarim* (28:27) referred only to those skin lesions that afflicted the *chartumim*, who were the priests, sorcerers, and educators of Egypt. This then explains why the sorcerers were unable to stand before Moshe, as these incurable skin lesions affected their knees and legs (*Devarim* 28:35). Rav E. Ginzburg [17] also postulated that the sorcerers were never healed of the boils and, therefore, never again appeared before Pharaoh to offer their advice. Rav Belsky [13] cited a Yiddish commentator who suggested that the *chartumim* were trained in special facilities in the city of Khartoum, the capital of Sudan, where they were trained in philosophy, science, astronomy, and the occult.

There are many opinions of the physical nature of these skin boils. In the Talmud (*Bava Kamma* 80b; *Bechoros* 41a), these skins boils are described as internal dry lesions which erupt through the skin surface to form an outer moist blister. Alshich (as interpreted by Rav Munk (2000) [18]) suggested that the plague caused blood blisters and pus pimples on the internal mucous membranes and a dry rash on the outer skin. The Rashbam, as translated by Rav Munk (2003) [19], noted that the boils were infected with bacteria and Rav S.R. Hirsch [1] described the skin boils as an inflammatory condition terminating in pus, tissue necrosis, and gangrene. *Sefer HaYashan* added that these gangrenous lesions were malodorous.

What caused the blisters and rashes? Ramban, *Sefer HaYashar*, and *Targum Yonathan* (as cited in *Me'Am Loez*) suggested that the ashes thrown into the atmosphere were hot and when deposited on the Egyptians and their livestock caused skin pathologies. Ramban, however, provided another thought, suggesting that the soot adversely affected the Egyptian atmosphere and it was this polluted air that caused the skin eruptions. Perhaps, mixtures of caustic gases (e.g., hydrogen cyanide; ammonia) were responsible for the rashes and blisters. Rav Aryeh Kaplan [5] adds a modern interpretation. When Moshe threw the fine ash "heavenward" (*Shemos* 9:8), it was hurled so far that it escaped the Earth's atmosphere and picked up "the elemental power of the sun," which he defined as cosmic radiation. According to this theory, the skin lesions were caused by radioactive fallout. Beta burns are shallow surface skin burns caused by beta particles in radioactive fallout,

usually seen after nuclear tests. On July 16, 1945, the first atomic bomb was tested in an isolated desert region in New Mexico. The code name for the test was Trinity. After the Trinity test, radioactive fallout, appearing as small flaky dust particles, caused localized burns on the backs of cattle in the area downwind of the test. Castle Bravo was the code name of the first U.S. test of a thermonuclear hydrogen bomb. Detonated on March 1, 1954, at Bikini Atoll, Marshall Islands, radioactive fallout again was generated. A snow white dust-like powder fell for 12 hours and poisoned the islanders who inhabited the test site, as well as the crew of Daigo Fukuryū Maru ("Lucky Dragon No. 5"), a Japanese fishing boat in the test area. Both the native islanders and the crew of the fishing boat suffered severe skin lesions [20]. These descriptions of radioactive fallout and the skin lesions that ensued are reminiscent of the sixth plague.

Pharaoh was a stubborn person and it would take another four plagues and the total destruction of his army before he understood that *HaShem* controls the world. Interestingly, in our tradition, Pharaoh flees to, and becomes the ruler of, Nineveh, the same city that, later in history, Yonah relayed *HaShem*'s command of repentance (*Baal HaTurim*; *Shemos* 14:28). Apparently, Pharaoh learned his lesson and the city repented (at least, temporarily). ■

ACKNOWLEDGEMENTS

Appreciation is expressed to Rabbi Eric (Eli) Babich, program director, of the Jewish Enrichment Center, New York, NY, for reviewing this manuscript.

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