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YESHIVA UNIVERSITY
STERN COLLEGE FOR
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Derech HaTeva

דרך הטבע



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DEDICATION & ACKNOWLEDGEMENTS

DEDICATION

We dedicate this sixteenth volume of *Derech HaTeva: a Journal of Torah and Science* to Gilad Shalit, who was returned from captivity to his home in Israel. Gilad Shalit, an Israeli soldier serving in the IDF, was captured inside Israel by Hamas militants on June 25, 2006 in a cross-border raid near Gaza. After being held in captivity for five years, he was released on October 18, 2011, the sixth day of the holiday *Sukkot*, *z'man simchateinu*. The miracle of his return and the immense joy that it has brought *Am Yisrael* provides strength and inspiration for us to appreciate G-d's miracles, both big and small.

ACKNOWLEDGEMENTS

We would like to thank Dr. Babich for his immeasurable help in bringing this volume to print. His unyielding dedication to this publication and to the Biology Department at Stern College has enabled his students to develop and deepen their passion for *Torah U'Madda*.

Kate Rosenblatt

Rose Snyder

Helen Unger

PASUK

אחינו כל בית ישראל	As for our brethren, the entire House of Israel
הנתונים בצרה ובשביה	Who still remain in distress and captivity,
העומדים בין בים ובין ביבשה,	Whether on sea or on land,
המקום ירחם עליהם	May G-d have compassion on them,
ויוציאם מצרה לרוחה	And bring them from distress to relief,
ומאפלה לאורה	From darkness to light,
ומשעבוד לגאולה	From servitude to redemption,
השתא בעגלא ובזמן קריב	At this moment, speedily, very soon;
ונאמר: אמן.	And let us say Amen.

-Weekday Prayer Service

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HEALING THE UNBORN: FETAL SURGERY AND HALAKHA

Geulah Ben-David

Fetal surgery is a controversial procedure in the treatment of fetal abnormalities. A fetus's ability to regrow organ tissue in the womb is remarkable and, as such, fetal surgery can correct *in utero* an otherwise fatal disease. In its current stage of development, however, fetal surgery is clinically experimental and regarded as an invasive treatment. Furthermore, the ethical dilemmas surrounding fetal surgery are relatively new and have yet to be investigated thoroughly. Moral debates surrounding this topic question when personhood begins and if a mother should sacrifice her own life for her unborn child. *Halakha* resolves this conflict by recognizing that the fetus is a part of its mother and is not her equal until birth. When the fetus puts the life of the mother at risk, the *halakhic* perspective is that until birth, the mother's life takes precedence over that of her fetus. In this article I explain topics surrounding fetal surgery, an issue that has risen from advances in biotechnology. Fetal surgery has proven effective in specific cases, for example, in the treatment of spina bifida, clinically described as myelomeningocele. In such cases, the consent of both parents, doctor, and rabbi must be practically weighed to determine whether the benefits outweigh the risks.

Fetal surgery includes a range of *in utero* procedures used to treat birth defects in fetuses. Prenatal operations, enabled by the diagnostic ability of the ultrasound, are both risky and rewarding [1]. Fetal surgery is perceived as a last resort and is still considered new and experimental. Some of the defects that may be treated include severe spina bifida, serious heart defects, and bladder blockages. Although it has been acknowledged that to obtain favorable results some of these abnormalities are better treated *in utero*, currently available techniques must be improved to achieve better clinical effectiveness.

The underlying idea is that surgical intervention on the fetus is designed to fix pathologies that would be too advanced once the baby is born. There are noted surgeries which have been performed successfully and which have provided new hope to otherwise fatal birth defects. However, this comes with the risks of pre-term labor and possible harm to the mother's womb [2]. This raises ethical dilemmas questioning at which point does life begin

and how much should a mother be permitted to sacrifice for her unborn child. These questions have yet to be answered.

Man's creation "in the image of God" confers infinite value on every innocent human life and renders its destruction a capital offense.

The underlying idea is that surgical intervention on the fetus is designed to fix pathologies that would be too advanced once the baby is born.

Fetal surgery challenges our perspective on when life begins. At what point can full membership to the human community be accorded to a developing fetus? There are three basic opinions to consider regarding the status of an embryo and, later, a fetus. The first opinion is that personhood begins at the moment of fertilization. Another opinion is that the status of a human is acquired in a progressive manner during pregnancy and is completely achieved at birth. Some share the opinion that personhood relies on properties that relate to the functional level of the human brain, specifically cognitive and emotional infrastructures. According to this view, personhood begins when the nervous system has a significantly developed infrastructure. During pregnancy, the fetal brain achieves this during the third trimester. Accordingly, it can be concluded that a fetus should be treated with the appropriate respect that would be designated for a fetus, although not with that expected for a person [3].

Because fetal surgery is presently at a very experimental stage, its risk outweighs any other consideration. The only case in which fetal surgery might currently spark controversy is in a *halakhic* sense regarding the treatment of spina bifida. The clinical research in treating spina bifida with fetal surgery has produced significant outcomes, making fetal surgery a viable treatment option. Nevertheless, understanding the implications of *in utero* surgery is a good place to start.

The *halakhic* perspective, based mostly upon Biblical and Tal-

judic law, is that the status of a human is only acquired in a progressive manner during fetal development and not at the point of fertilization. Some *halakbic* authorities consider the fetus a part of the mother's body. Thus, if the fetus endangers the life of the mother and is viewed as a *rodef*, defined as one who "pursues" the life of another, then it should be sacrificed to save the life of the mother [4]. According to *halakha*, the status of the fetus is equal to the mother's only at birth.

Another fundamental rule of *halakha* that pertains heavily to this discussion is that one life must not be sacrificed to save another. There are, however, exceptions to this rule. During delivery, a fetus can be sacrificed to save the life of the mother. It is recorded in the *Mishna in Ohaloth* (7:6), "If a woman is having difficulty during childbirth, it is permissible to destroy the fetus surgically because her life comes first. If, however, the head of the fetus has already been delivered, then it is forbidden to intercede even though it may cost the life of the mother. The fetus is now an infant with the ability for an independent life. Therefore, we do not sacrifice one life to save another" [5]. Fetal surgery comes into play once we realize that turning to surgical intervention risks the mother's life for the potential to heal the unborn. This raises an additional question: if we know that the procedure has a decent chance at being successful, but is risky, how much risk can we take at the expense of the mother's life? A similar question applies if there is a poor prognosis that the procedure will be successful.

What risk, if any, are we allowed to take to save an unborn fetus?

Scientific progress has caused a need to redefine many *halakbic* understandings and perspectives. It is therefore difficult to answer these questions until these procedures produce greater clinical effectiveness, promising better outcomes for the mother and her potential child [6]. Until then, fetal surgery is a personal matter that must seriously be weighed by the mother, father, rabbi, and doctor.

Further research must be done regarding this matter in terms of how effective these procedures are and how to develop better techniques. There are distinctions between different types of fetal surgery. As such, we must recognize that obstructive uropathy or spina bifida may be abnormalities deemed necessary to correct in the womb, whereas other abnormalities would not be given the same treatment. Permitting less invasive procedures is a stepping stone until progress is made in perfecting fetal surgery as a tool for treatment of fetal abnormalities. Gradually, successful outcomes of *in utero* surgeries will hopefully increase, and the task of defining the *halakbic* and ethical implications will become a more pressing necessity. Fetal surgery is an extremely sensitive topic that should not be overlooked. It is crucial to take into consideration the autonomy of the pregnant woman with respect to the interest of her fetus [7]. The mother's selfless act can cause damage to herself, and thus, it is essential for the physician to carefully evaluate the interests of both the fetus and its mother. ■

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A ROYAL DISEASE: CAN A HEMOPHILIAC BE CIRCUMCISED?

Rebecca Benhaghazar

During the nineteenth and twentieth centuries, European royalty suffered from a sex-linked genetic disease that prevents blood clotting, known as hemophilia. It is believed that Queen Victoria passed on the X-linked mutation to her two daughters, Princess Alice and Princess Beatrice. The disease had a calamitous effect upon the British royal family. The nineteenth century Duke of Albany, for example, slipped, fell, and died of blood loss in the year 1884. Queen Victoria's grandson, Friedrich, died from exsanguination, fatal blood loss, at the young age of two years old. Similarly, Leopold and Maurice, two other grandsons, died at the ages of thirty-two and twenty-three, respectively. Many of Queen Victoria's heirs inherited the disease, and as they married into different royal families, the pathology was dubbed the "royal disease" and spread through the royal families of Britain, Spain, Russia, and Germany. Through DNA analysis on the bones of the Russian royal family it has been discovered that Russian royalty, the Romanovs, suffered from a rare subtype of the blood clotting disorder, hemophilia B [1].

Hemophilia is an X chromosome-linked disorder that may be inherited from either the mother or the father; however, hemophilia is nearly exclusively manifested in males. Males, said to be hemizygous, inherit one X chromosome from their mothers and thus have a single copy of all X-linked genes. Women, on the other hand, inherit two X chromosomes, giving them a "double dose" of sex-linked genes. Although the trait for hemophilia is recessive, since males inherit a Y chromosome from their father, which lacks the gene for blood clotting, they are unable to mask a deleterious gene on their X chromosome. Females may be carriers for X-linked diseases if they carry the deleterious gene on only one X chromosome, giving them a fifty percent chance of producing affected sons [2].

As mentioned previously, hemophilia is a disorder that prevents blood from clotting normally in the event of a wound. For a hemophiliac, even a minor cut can bleed for a long period of time. When one bleeds, the body launches a series of reactions, called the coagulation cascade, to clot the blood [2]. The coagulation cascade involves proteins known as coagulation factors. One has a higher chance of bleeding when one of these coagulation factors

is missing. Hemophilia A is characterized by a lack of the blood clotting factor VIII. Without sufficient factor VIII, the blood cannot clot properly to stop bleeding. Hemophilia B is characterized by a deficiency of blood clotting factor IX. Similarly to hemophilia A, one who is affected by hemophilia B lacks the ability to clot normally in order to control bleeding [3].

Evidently the scholars of the Talmud, as described by Maimonides and Rabbi Joseph Karo, recognized that hemophilia is transmitted maternally, and that it causes exsanguinations, leading to the death of the circumcised child.

Records of medical literature indicate that hemophilia was first discovered in 1803 by John Conrad Otto [3]. However, long before Otto, a passage from the Talmud conveyed that the genetics behind the sex-linked blood clotting disorder was understood. Rabbi Judah and Rabbi Simeon hold differing beliefs in the amount of repetitive events necessary to establish a pattern for the transmission of hemophilia. On the one hand, Rabbi Simeon believed one should wait after the passing of three sons who died as a consequence of circumcision in order not to circumcise the fourth child; however, Rabbi Judah believed the third child should not be circumcised. If the mother found that circumcising her first two sons resulted in their death, she should not circumcise her third son. The twelfth century Biblical commentator and physician, Maimonides, detailed in his work the *Mishneh Torah, Sefer Abavah, Hilchot Milah* 1:18, that hemophilia was undoubtedly transmitted from the mother. Maimonides explained that if a woman's first son died as a result of circumcision, which "enfeebled his strength," and her second son also died as a result of circumcision, regardless of whether her second son was from her first husband or second husband, she should not circumcise her third son. Further extrapolating on Maimonides' work, Rabbi Joseph Karo explained that there are families "in which the blood

is weak;” furthermore, like Maimonides, Rabbi Karo explained that the mother should not circumcise her third son in the event that her first two sons died after circumcision [5]. Evidently the scholars of the Talmud, as described by Maimonides and Rabbi Joseph Karo, recognized that hemophilia is transmitted maternally, and that it causes exsanguinations, leading to the death of the circumcised child.

While performing surgery on hemophiliacs could pose many problems because of their inability to clot, modern medical and technological advancements have made many surgeries possible, including protocols that make it feasible to circumcise hemophiliacs. This procedure relies upon factor concentrate replacement therapy followed by continuous post-surgery replacement therapy for diverse periods of time. Haemostatic agents, substances that promote the stop of bleeding, such as fibrin glue, are used during the procedure. Fibrin glue is a topical adhesive that imitates the function of clotting factors in that it emulates last stages of coagulation. The haemostatic agent has proven to be successful in controlling bleeding in other realms of surgery, such as in neurosurgery and cardiovascular surgery. In the event that the missing clotting factor is provided to the hemophiliac baby to safely perform circumcision, some Rabbis prohibit the circumcision on the Sabbath if the missing clotting factor would have to be ad-

ministered intravenously [6]. Rabbi J. David Bleich considered the aforementioned procedure; however, he also explored an alternative route in the pursuit of circumcising a hemophiliac: laser surgery. Rabbi Bleich stipulated that laser circumcision can satisfy the requirement of circumcision to be a *koah adam*, a human act, because the already existing laser rays are brought to bear upon the foreskin by a direct human act [7]. On September 5th, 1998, Judy Siegel, a writer for the Jerusalem Post, reported that a two-month-old baby of Israeli immigrants had undergone laser surgery. Dr. Shlomo Wallfish, who had initially performed laser circumcision a decade earlier, performed the laser circumcision on the young child [8].

Circumcision has been an ongoing practice for the Jews for thousands of years. Even during the midst of persecution when circumcision was forbidden, the Jewish people resorted to daring measures to ensure the continuation of the ritual. However, the *halakhic* ramifications of performing the traditional procedure on a hemophiliac have since evolved. Medicine has greatly advanced since the times of our Talmudic sages who stipulated that if hemophilia was a confirmed genetic disease in the family it should not be performed on a hemophiliac. Today, the use of haemostatic agents and laser surgery allows a hemophiliac to take part in the sanctified practice of circumcision. ■

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A RUNNER'S "QUICK" FIX: MEDICAL SPLENECTOMIES IN THE TORAH

Ayelet Bersson

Competitive runners are always looking for the newest and most effective techniques to increase their speed. Be it specific foods, special training programs, or unfortunately, certain drugs, the price for speed is never too great. This need for speed is an age-old endeavor, sought after even in biblical times.

In the first *perek* of *Melachim Alef*, King David's health declines and his son, *Adoniyah*, senses this vulnerable moment as the opportune time to seize the throne. *Adoniyah* quickly gathers the Jewish nation for a coronation ceremony, riding before them in his chariot with "*chamishim ish ratzim lifanav*," "fifty men running before him" (*Melachim Alef* 1:5). The *Gemara* in *Sanhedrin* (21B) comments on this *pasuk* that these specified servants of *Adoniyah's* had their spleens surgically removed, enabling them to run faster. *Rashi* further elucidates that the spleen weighs a person down; thus, its removal causes increased speed.

As unusual as the *Gemara's* explanation sounds, removal of the spleen to increase speed was actually a common surgical procedure throughout ancient times. In Pliny the Elder's *The Natural History*, a Roman encyclopedic work written around 77 AD, Pliny cites an idea that the extirpation of the spleen "renders runners more efficient" [1]. In the Greek culture as well, marathon runners often removed their spleens to increase their chances of winning competitions [2]. Furthermore, there exists an old French saying, "To run as one with his spleen out," which clearly exhibits the belief that speed is accelerated with the extirpation of one's spleen [3].

The notion that the spleen plays an inhibiting role in swiftness is not just an obsolete, archaic concept. Twentieth century German physician and scholar, Julius Preuss, followed by Fred Rosner, Yeshiva College graduate and current Assistant Dean and Professor of Medicine at Albert Einstein College of Medicine, both firmly believe the *Gemara's* statement describing the spleen's adverse effect on speed. Preuss and Rosner both understand the *Gemara* literally, even within a scientific lens, that *Adoniyah's* physicians removed the footmen's spleens in order to increase the soldiers' speed [1, 4].

Preuss's belief that the spleen inhibits swiftness was even-

tually tested in 1922 by Jewish pharmacologist, David Macht. Macht, a professor at Johns Hopkins University, (and at Yeshiva College for a brief time), firmly believes in the synchronization of scientific discoveries with Torah and Talmudic ideas. Having read this *Gemara*, Macht decided to investigate the Talmud's claim, and devised an experiment to research the correlation between medical splenectomies and speed. He trained fifty rats to walk across a thin rope, hypothesizing that the extirpation of the spleen would increase their speed and muscle coordination. Macht then splenectomized thirty rats, leaving twenty as his controls. As hypothesized, the average time to cross the rope decreased from 6.8 seconds to 4.6 seconds, signifying a correlation between spleen removal and advanced speed and muscle integration [3].

These specified servants of Adoniyah's had their spleens surgically removed, enabling them to run faster.

While Macht's experiment attests to the ancient understanding of the spleen as an impediment to one's speed, a major pragmatic question arises. How could a complicated surgery, that had a twenty-eight percent mortality rate even in the early twentieth century, have been performed so successfully with such a high survival rate before the discovery of antibiotics and modern surgical technology [2]?

One plausible resolution to this question is in *Rambam's* twelfth century medical writings, where he states that the dangerous splenectomies were never performed in King David's time. Instead, *Rambam* insists that *Adoniyah's* soldiers were given herbal drugs that shrunk their spleens, thereby decreasing the inhibiting weight [2].

Rashi's interpretation of the *Gemara* in *Sanhedrin* (21B) might be the basis of *Rambam's* herbal interpretation. *Rashi* explains that the soldiers were given certain drugs that enabled safe spleen removal. Unlike *Rambam*, however, *Rashi* maintains that the spleens were definitely removed, and not just atrophied. Thus the ques-

tion still exists, how could such a dangerous surgery have been performed in ancient times, even with herbal drugs and medicines?

To understand how surgical splenectomies could have been performed regularly with such a high success rate, one must look at the surgical conditions used during the time of the Talmud. The *Gemara* in *Kesubos* 77B discusses the standard procedure for cranial surgery performed then, describing the herbs used for anesthetics and the sterilized marble surfaces where surgery was performed. Clearly, the physicians of Talmudic times had some

understanding of certain surgical practices that only became standard medical procedure as of the late nineteenth century [5].

With this understanding of ancient Jewish surgical procedures, one might conjecture the possibility of medical splenectomies performed on *Adonija's* footmen. An understanding of the spleen's inhibitory role in speed, coupled with the advanced anachronistic knowledge of antiseptic surgical conditions, advocates the *Gemaras'* and *Rashi's* interpretation that *Adonija's* fifty footmen were specifically chosen in light of their increased running speed, a result of spleen removal. ■

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FATE TO DESTINY: THE BRCA GENE AND THE JEWISH COMMUNITY

Tehilla Brander

“The individual is tied to his people both with the chains of fate and the bonds of destiny,” writes Rav Soloveitchik [1]. Fate unites the Jewish people as a result of a shared history. Jews are a people of fate because of events beyond their control. Today, this shared history can be seen not only in historical events, but in the foundation of life itself: the genetic code. Scientists are able to trace mutations that are unique to Jews and link these mutations to various periods in Jewish history. One such example is the BRCA 1/2 mutation, which can increase the risk of different cancers including breast cancer. Scientists have traced this mutation “prior to the dispersion of the Jewish people in the Diaspora,” making it a constant marker for the shared Jewish fate [2]. While fate describes the inevitable, there is another element that characterizes the Jewish nation; Jews are a people of destiny, a people who ask not “about the cause of evil...but rather how it might be mended and elevated” [1]. As a people of destiny, the Jewish community has a responsibility to face challenges that arise, whether they are political or genetic in nature. With new scientific advances, the Jewish people can become a nation of destiny, despite the fate of various genetic mutations.

Before exploring the options in addressing the BRCA-1 and BRCA-2 mutations, it is important to understand the implications of inheriting these mutations. At the phenotypic level, acquisition of the BRCA mutation results in a heterozygote with a dominant predisposition for developing cancer. As noted in pedigree analyses, the development of cancer follows a dominant pattern with incomplete dominance. It is the loss of function of the normal copy of the BRCA gene in a somatic cell that may lead to the actual development of cancer, affecting both men and women. Acquisition of mutated BRCA genes has been linked to an increased risk in breast, ovarian, prostate, and other forms of cancer [3]. The BRCA mutation is a risk factor, meaning that though the predisposition to cancer is inherited in a dominant fashion, it is only a risk. As such, it is possible that a person who has the mutation may not develop cancer. Furthermore, there are procedures that can help prevent and fight cancer, including increased screenings, oophorectomy, mastectomy, and chemoprevention. Yet one must

still consider that the risk of developing breast cancer is significantly raised with the inheritance of a mutated BRCA gene. In the general population about 12% of women will develop breast cancer. However 60% of women who have inherited the BRCA mutation will develop breast cancer. In other words, a woman who has inherited the BRCA mutation is five times more likely to develop cancer [4].

As a result of the founder effect, certain mutations of BRCA are more commonly found in populations of Ashkenazi descent and were recently discovered in Sephardic communities.

The inheritance of the BRCA-1 and BRCA-2 mutations has particular significance to the Jewish community. Apparently, many generations ago the BRCA mutation originated in a specific individual, termed the founder. Possibly because of persecutions, a small group of Jews separated from the larger Jewish community to live in an isolated region. Within this small group was the founder. As Jews tended to marry within their own limited and isolated communities, a founder effect occurred, magnifying the allele frequency of the BRCA mutation within the isolated community. As a result of the founder effect, certain mutations of BRCA are more commonly found in populations of Ashkenazi descent and were recently discovered in Sephardic communities [2]. In the non-Jewish population it is estimated that a person has a 1 in 300 to 500 chance of inheriting these mutations [5]. However, in the Ashkenazi Jewish community it is estimated that about 2.3% carry this mutation which is five times higher than that found in the general population [4]. With the knowledge that the BRCA mutation is more frequent in Jewish populations, many Jews are genetically predisposed for a higher risk of developing hereditary breast or ovarian cancer. One must consider how to take charge of this challenge and alleviate the predisposition to these malignancies within the Jewish population.

At first glance, one may consider applying the premarital testing model, already in place for preventing Tay Sachs, to BRCA-associated malignancies. However, considering the differences in inheritance patterns and in the diseases themselves, it becomes apparent that this is not an option. Tay Sachs disease is caused by an inherited recessive mutation, which does not allow the breakdown of certain fats, especially in the neurons of the brain. A child born with this disease will exhibit adverse symptoms, starting around 6 months, that progressively worsen until the child dies typically around the age of four or five [6]. There is no medical cure for Tay Sachs disease. To prevent this disease, the Jewish community advocated for premarital genetic screening tests, in which a person is tested to determine that person's genetic status; that is, whether completely free of the Tay Sachs mutation or a carrier of the mutation. A carrier would typically avoid dating another carrier because marriage between two carriers produces a 25% chance of producing a Tay Sachs baby. This model is possible because the mutation is recessive, the carrier is unaffected, and the concern arises only when two carriers marry each other. A carrier marrying a non-carrier is fine because this match cannot produce offspring with Tay Sachs disease. However, the predisposition to BRCA-associated cancer is inherited in a dominant manner. Therefore, if the normal copy of the BRCA is inactivated in a somatic cell of the carrier, the carrier may be affected and develop a malignancy. Furthermore, regardless of the genetic status of the carrier's mate, future progeny have a chance of being affected. Unlike Tay Sachs, once a BRCA carrier transmits the mutated gene, a carrier child who inherited one copy of the defective gene has the same risk factors as the carrier parent [7]. Additionally, the issue of stigma and anguish arises, especially during *shidduchim*, as being labeled a BRCA carrier might deter potential suitors. Another difference is that Tay Sachs disease is incurable, whereas the BRCA mutation is a risk factor and not an absolute predictor of cancer. There are also measures that can be taken to try to prevent cancer that results from the BRCA mutation, including more regular screenings and prophylactic surgeries, like a mastectomy and/or hysterectomy [7, 8]. For the above reasons one cannot apply the same population model of Tay Sachs to BRCA.

While current BRCA carriers have options in dealing with their carrier status, there is still a larger question of how to prevent the continuation of this mutation in future generations. One possible solution is the use of preimplantation genetic diagnosis (PGD), a procedure that utilizes *in vitro* fertilization (IVF) techniques, allowing couples to select those preembryos for implantation based on their genetic suitability. A woman's eggs are fertilized *in vitro* (i.e. in a Petri dish) and tested for genetic constitution.

Those preembryos that do not carry the mutation are chosen for implantation into a gestational carrier. Studies have found that "PGD is an acceptable reproductive option for BRCA mutation carriers, especially for those who require IVF due to fertility problems" [9]. When considering applying this technique in individual cases, there are social and *halakhic* issues that should be taken into consideration.

The question of when one should be tested for the BRCA mutation has been debated. If one is tested before marriage, the carrier may be stigmatized and have a more difficult time getting married. Furthermore, early testing may cause additional mental anguish, as the individual will constantly fear a cancer that, in fact, may never develop. However, to consider PGD, one must be informed of the mutation prior to having children. It is also worth noting that PGD is a challenging process financially, psychologically, and physically. While PGD may be suited for couples who already require IVF treatments due to fertility challenges, using this protocol on a communal scale may be impractical. Additionally, one must address whether it is *halakhically* permitted to perform PGD in this situation. *Machon Pnab*, an organization that assists with *halakhic* issues of infertility, has discussed this issue with major *poskim*, and "almost all said they would permit a couple to undergo PGD for BRCA mutation" [10]. A few *poskim* have even asserted that "the birth of a healthy child is paramount and overcomes other *halakhic* considerations; therefore the couple must undergo PGD" [11]. Other *halakhic* authorities allow PGD because it can prevent potentially life-threatening diseases. However, these *poskim* do not make PGD obligatory as the *mitzva* of having children would be fulfilled even by having a child with the BRCA mutation [11]. There are other *poskim* who believe that PGD as a method of genetic selection against BRCA is not permitted. Some believe that IVF should only be used in cases of infertility. Others believe that PGD should only be used for life-threatening diseases like Tay Sachs. Since BRCA is only a risk factor and certain cancers can be cured or prevented, PGD should not be used for BRCA [10]. *Machon Pnab* advocates that each case be dealt with on a case-by-case basis as PGD raises many complexities. In families where the BRCA mutation has historically caused cancer, PGD is worth discussing with a *posek*.

Just as the Jewish people do not simply accept the fate of historical events, such as the events of the Diaspora, but take an active role in molding and bettering the future, we must address genetic challenges with a similar mindset. The Jewish people should not be passive when addressing BRCA issues, which are as old as the Diaspora itself. With the advent of PGD, the option for screening preembryos for possible genetic mutations allows

for the eradication of the BRCA genes in specific cases. However, dealing with these issues on a communal level and creating a communal protocol is more complex. The issues surrounding a communal response to the BRCA mutation requires further in-

vestigation. By raising the issue, exploring solutions presented by emerging technology, and offering support to members of the community facing this challenge, we will transition from a people of genetic fate to a people of genetic destiny. ■

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VAMPIRES AND WEREWOLVES

Batya Edelman

Mythical creatures such as vampires and werewolves have been popular subjects in recent literature and media. Today's portrayal of these creatures is vastly different from the original tales dating back to prehistoric times. Almost all societies told legends about blood drinkers and humans that could transform into wolves [1, 2]. According to many Ka'abbalistic leaders, there are parallels of these creatures within Judaism. These stories were accepted as truth when the world was a mystery to man, but as medicine and science became more understood by man, so too these legends were understood to be fictional. The only question that remains is which natural occurrence ancient humanity was trying to explain through these myths.

There are several Jewish commentators that describe blood-drinking creatures and humans that morph into wolves. The *Sefer Chassidim* discusses a creature referred to as the *estrie*, which resembles the vampire [3, 4]. The *estrie* was a creature that *Hashem* created at twilight on the first Friday, but its creation had not been completed before *Hashem* rested on the first *Shabbos*. Several stories are also related, in which the *estrie* is described as an evil being. One story relates the tale of an ill female *estrie* who was guarded by two innocent women. When one of the women fell asleep, the *estrie* unraveled its hair and tried to suck the blood out of the sleeping woman. The second woman cried out, awakening the sleeping woman, and together they stopped the *estrie* from carrying out its evil act. The *estrie* needed the blood of the woman to survive because "a being who was created from blood needs to swallow blood from flesh." Without this blood the *estrie* would die [3, 4].

Rabbi Menachem Zioni states that the builders of the tower of *Bavel* were transformed into vampires, werewolves, spirits, and monsters. He also writes about people who anointed themselves with specific oils, which enabled them to fly. However, these people, with their new capability to fly, had to return home before dawn [3]. *Rabbi Ovadya Sforno* also discusses blood-drinking demons. He states that the Torah prohibited Jews from drinking the blood of animals to prevent them from associating with these demons. He also includes the reason why the demons must drink

blood: since they are made from vapor they must consume the vapor of blood [5]. *Rabbeinu Ephraim* states that *Binyamin* had sons that resembled the species of the wolf. He also tells of a human who turned into a wolf, whose legs protruded from the shoulders [6, 7]. These creatures that are discussed in Jewish commentaries are inherently different from the mythical vampire and werewolf, but similarities still remain.

There are a variety of different diseases that may have led to the creation of the mythical creatures of vampires and werewolves.

There are a variety of different diseases that may have led to the creation of the mythical creatures of vampires and werewolves, though only three will be discussed. Patients with rabies, porphyria, and hypertrichosis exhibit symptoms that are similar to the characteristics associated with vampires and werewolves.

Rabies is a viral disease that is usually transmitted through animal bites from affected mammals. The rabies virus is a single-stranded RNA virus that first reproduces in muscle cells. It then binds to the nicotinic acetylcholine receptors at the neuromuscular junction, which is where nerve cells relay messages to the muscle cells. The RNA virus then replicates within the neurons. Next, the virus enters the central nervous system and invades the brain neurons leading to neuronal dysfunction. Once the brain is infected, the virus can travel through the nerves to affect the salivary glands, skin, heart, and other organs. The advancement of the virus can take weeks or even months after the virus first enters the body. The disease leads to a variety of terrible effects. These include slight paralysis, cerebral dysfunction, anxiety, insomnia, confusion, agitation, paranoia, terror, hallucinations, and delirium. The production of large amounts of saliva coupled with the slight paralysis of the jaw leads to the inability to swallow and the characteristic foaming of the mouth. Encephalomyelitis (inflammation of the brain and spinal cord) causes the affected individual to enter a coma, and death follows shortly thereafter

[8, 9]. Vampire and werewolf myths can be associated with these symptoms. The foaming of the mouth, insomnia, and abnormal behavior coupled with the fact that the affected individual may feel an intense need to bite (as has been documented in some cases) is where vampire and werewolf stories may have originated from. Transformation into vampires and werewolves through saliva and bites from these mythical creatures is a common thread in many legends. Additionally, many cases of rabies transmitted via bats and wild carnivores, including wolves, have been documented [8, 9]. This may be the origin of the legends in which vampires turn into bats and humans turn into wolves.

Hereditary porphyrias are a group of eight diseases, the symptoms of which are very similar to characteristics of vampires and werewolves. These diseases occur due to the malfunction of the heme biosynthesis pathway. Heme is comprised of porphyrin rings and is produced in every cell of the body, though mainly by erythropoietic cells and liver cells. Erythropoietic cells are involved in red blood cell production, and produce heme as a precursor to hemoglobin, the protein that transports oxygen to tissues in the body. Liver cells are involved in the production of cytochromes and haemoproteins. Cytochromes are part of the electron transport chain that is necessary for ATP formation. Heme production involves eight enzymes that convert glycine and succinyl CoA into the porphyrin rings. Three steps of heme production take place in the cytosol of the cell, while the rest of heme production takes place in the matrix of the mitochondria. The first enzyme, 5-aminolevulinic acid synthase (ALAS), converts glycine and succinyl CoA into D-aminolevulinic acid. ALAS is coded by two genes, one on chromosome X (ALAS2) and one on chromosome 3 (ALAS1). ALAS1 is the rate-limiting step in the production of heme in the liver, while heme production in erythrocytes is related to iron availability and is not limited by the enzymes in heme production. A mutation of ALAS1 leads to X-linked dominant protoporphyria. In the second step, ALA dehydrogenase converts ALA into porphobilinogen (PBG), and is associated with ALA dehydratase porphyria. Porphobilinogen deaminase then converts PBG into hydroxymethylbilane, though a mutation can cause acute intermittent porphyria. Following this, uroporphyrinogen III synthase produces uroporphyrinogen III. If the enzyme is not functional, this leads to congenital erythropoietic porphyria. Porphyria cutanea tarda has been linked to the fifth step, in which UPIII decarboxylase forms coproporphyrinogen III. CPIII oxidase then produces protoporphyrinogen IX, which, if nonfunctioning, leads to hereditary coproporphyria. In the seventh step, protoporphyrin III oxidase (associated with variegata porphyria) generates protoporphyrin IX, which ferroche-

latase (FECH) finally converts to heme. A nonfunctional FECH is linked to erythropoietic protoporphyria. In porphyria a mutated enzyme may be somewhat functional, but will catalyze reactions at much slower rates. Because of this, the substrate for the reaction will build up causing a variety of deleterious effects in the cell, and heme production will be dramatically slowed [10, 11, 12].

Patients with porphyria may present with a variety of symptoms that have been attributed to vampires. The symptoms vary with the type of porphyria and the patient. Some experience skin fragility and blisters and/or a burning sensation when exposed to sun. Others experience severe photosensitivity. If the central nervous system is affected, then insomnia, anxiety, hallucinations, depression, and convulsions may occur. Red teeth and red urine is another indication of porphyria. These symptoms are very similar to the medieval myths of vampire appearance and behavior. The legend that vampires suffer skin burns from the sun, and therefore only come out at night, explains the photosensitivity, skin blisters, insomnia, and the burning sensations. The strange behavior of the vampire can be attributed to the anxiety, hallucinations, and depression. The myth that vampires drink blood may have originated from the red teeth and urine observed in people afflicted with porphyria. Interestingly, the link between vampires and werewolves is also explained through porphyria, as some patients with porphyria grow excessive hair on their bodies [10, 11, 12].

Hypertrichosis is a rare disease in which afflicted individuals produce excessive hair due to larger amounts of hair follicles. The excessive hair growth causes affected individuals to appear wolf-like. There are over fifty different variations of the disease, including one called congenital generalized hypertrichosis (CGH). One mutated gene that can cause this syndrome is found on the X chromosome, and has been associated with gingival hyperplasia, a flattened nose, and elongated ears. Gingival hyperplasia leads to thickening of the gums of the mouth and can cause the appearance of a malformed mouth. Since affected individuals present with these wolf-like features, the syndrome has been nicknamed the “werewolf syndrome” [13, 14]. The wolf-like characteristics may have led to the werewolf myths.

Vampires and werewolves may be mythical, but there are diseases that resemble these legendary creatures. Hypertrichosis, porphyria, and rabies all exhibit similar symptoms to the fictional vampires and werewolves. There are Jewish commentators that discuss creatures with similarities to the vampires and werewolves, although the essence is different in these commentaries. Although presented differently in Jewish commentaries, parallel creatures to vampires and werewolves exist in Jewish tradition. ■

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MUSIC TO MY EARS: A SCIENTIFIC ELUCIDATION OF KOL ISHA

Deborah Farber

The interpretation of the prohibition of hearing a female's voice has evolved within Judaism throughout the years. Perhaps a fresh look at this prohibition is warranted considering recent advances in modern neuroscience.

A woman's voice, according to the rabbis, can be attractive or sensuous, and therefore laws must be in place to describe when a man can listen to a woman's voice. The halachic prohibition that the rabbis instituted for "*kol b'isha ervā*" (a woman's voice is nakedness) originates primarily from two Talmudic sources. The first source is from a discussion in the Talmud in *masechet Brachot*. Several rabbis in this passage discuss the concept of *erva* (nakedness). *Rabbi Yitzchak* teaches that a woman's hair is *erva*, and *Rav Sheshet* teaches that a woman's legs are considered *erva* (*Brachot* 24a). *Shmuel* also expresses his opinion on the issue of *erva*, stating that a woman's voice is *erva* (*Brachot* 24a), and citing as proof, "For your voice is sweet and your appearance attractive" (Song of Songs 2:14). The second source of "*kol b'isha ervā*" is found in *masechet Kiddushin*. In this *gemara*, *Rav Nachman* asks *Rabbi Yehuda* to send his regards to *Yalta*, *Rabbi Yehuda's* wife. *Rabbi Yehuda* responds, citing *Shmuel*, that a woman's voice is *erva*, and therefore it is inappropriate to send greetings to *Rabbi Yehuda's* wife (*Kiddushin* 70a).

These passages pose several inconsistencies about the nature of a woman's voice. The prohibition of *kol isha* came to be interpreted in different ways by various leading rabbis. According to the interpretation of most German *rishonim*, including *Rabbi Eliezer ben Yoel Halevi*, the sources in *masechet Brachot* and *masechet Kiddushin* indicate that a man is prohibited from hearing a woman's singing voice while reciting *kriat shema*. This ruling was made in order to avoid distraction while partaking in religious activities that require one's full attention. Later rabbis began to interpret this prohibition to include other activities, in addition to *kriat shema*. However, *Rabbi Yosef Karo*, author of the *Shulchan Aruch*, merely advises that men should avoid hearing a woman's singing voice while reciting *kriat shema*. *Rabbi Moshe Iserless*, citing *Rabbi Yosef Karo*, shifts the advisory nature of *Karo's* statement to the status of law [1]. *Rabbi Eliezer ben Shmuel* of Metz extends this prohibition to include any *davar shebikedusha*, from which *Rabbi*

Mordechai ben Hillel extrapolates its application to the study of Torah [2].

A recent study performed at the University of Sheffield, under the guidance of psychiatrist Michael Hunter, could change the way we perceive the prohibition of *kol isha*.

Rabbi Saul Berman, Judaic Studies professor at Stern College for Women, points out a major issue with the rabbinic interpretations of *kol isha*. All of the rabbis mentioned above only consider the *gemara* in *Brachot*, which prohibits hearing a woman's singing voice. However, they ignore the prohibition of hearing a woman's speaking voice, as stated in the *gemara* in *Kiddushin* that relates the story of *Rabbi Yehuda*. In *Rabbi Berman's* article, "*Kol Isha*," he regards the interpretation of the *Rabad* of Posquieres to be significant because the *Rabad* deals with the inconsistency between these two Talmudic sources. The *Rabad* deems the restriction applicable to the woman's speaking voice as well, and not just her singing voice, as does the *Meiri* [3]. *Alfasi* and the *Rambam*, also cited in *Berman's* article, conclude that the prohibition applies to a woman's singing voice as well as her speaking voice, as the prohibition against listening to the woman's speaking voice seeks to prevent illicit social relationships between a man and a forbidden woman [2, 4]. These sources seem to indicate that hearing a woman's speaking voice is included within the prohibition of *kol isha*.

A widely accepted opinion regarding *kol isha* is that of *Rabbi Gumbiner*, commonly known as the *Magen Avraham*. He stated that the singing voice of a married woman is always forbidden, while her speaking voice is permitted [5]. This is the generally accepted approach among many Orthodox communities. However, there is much room for debate, given the plethora of halachic opinions as well as the ambiguous nature of the Talmud's statements on the topic of *kol isha*.

A recent study performed at the University of Sheffield, under the guidance of psychiatrist Michael Hunter, could change the way we perceive the prohibition of *kol isha*. Along with Hunter, Professor Peter Woodruff's group in the Department of Psychiatry and the Division of Genomic Medicine helped shed light on the true nature of a woman's voice, and its consequent classification as *erva*. Using functional magnetic resonance imaging (fMRI), researchers monitored the brain activity of 12 men while they listened to voice recordings. The subjects received 96 stimuli, consisting of male and female voices that were either gender-apparent (unaltered in pitch) or gender-ambiguous (pitch-scaled). The researchers found that the male brain processed voice stimuli differently depending on the gender of the voice stimulus. Male and female voices each activated different areas of the brain in male listeners [6].

The researchers found that perception of a male voice results in activity in the mesio-parietal precuneus of the brain, an area involved in episodic memory and imagination of sounds. Precuneus activation in the male brain during perception of a male voice was consistent with the idea that males compare the male voice stimuli with the internal paradigm of their own voice. In contrast, female voice stimuli activated human voice-selective regions of the right anterior superior temporal gyrus (STG), which is close to the superior temporal sulcus (STS). This finding is consistent with the idea that brain processes that attempt to attribute human qualities to voices are more involved in the perception of female voices than male voices. One explanation for activation of the STG by female voices is that female voices involve a greater employment of emotional prosody (affect and melody) than do male voices,

the identification of which involves the STG. It is suggested that female voices are acoustically more complex than male voices, as female voices result in greater activation of the auditory cortex. Studies have demonstrated that computer technology has greater difficulty in recognizing and synthesizing female voices [6].

Regarding the study, Hunter explains, "Voices allow the brain to determine various factors about a person's appearance, including their sex, size and age. It is much more complex than most people think and is an extremely important tool for determining someone's identity without having to see them" [7]. The findings from Hunter's experiment allow us to re-conceptualize our modern thoughts on *kol isha*. Given that a woman's speaking voice triggers a different part of the male brain than does a male voice, it is plausible that a woman's speaking voice, similarly to her singing voice, holds the potential to trigger sensual thoughts in male listeners. In the halachic realm, the *Meiri* further supports this claim by equating a woman's singing voice with her speaking voice [3]. Therefore, Hunter's experiment supports the claim that the prohibition of *kol isha* applies to both a woman's singing voice and her speaking voice.

Today, in Western culture, the prohibition of *kol isha* is seldom applied to a woman's speaking voice. While I am in no way offering a halachic *psak*, by taking Hunter's findings into account, we are able to recognize the reasoning behind those less prevalent opinions which also apply the prohibition of *kol isha* to a woman's speaking voice. Even though this opinion may not be treated as *halacha lema'aseh*, Hunter's experiment gives us the ability to appreciate the basis of this approach, ultimately teaching us that "*eilu v'eilu divrei Elokim Chayim*" (*Eruvin* 13b). ■

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FAMILIAL DYSAUTONOMIA AND ITS DENTAL MANIFESTATIONS

Shifra Glasner

Caused by a rare genetic mutation found almost exclusively in those of Ashkenazi Jewish descent, Familial Dysautonomia (FD), also known as Riley-Day syndrome, is a disease that affects the autonomic and sensory portions of the Central Nervous System. With approximately 600 cases diagnosed worldwide, FD is caused by a mutation of the IKBKAP gene on chromosome 9, a mutation occurring once in 3,700 births. A newborn diagnosed with FD has only a 50% chance of living until the age of 30[3].

Common symptoms of the disease include respiratory and cardiovascular dysfunction, diminished sensitivity to pain, lack of motorcoordination, incoordination of the gastrointestinal tract, absence of emotional tears, and spinal curvature. Patients experience what is known as a dysautonomic crisis brought about by physical or emotional stress. During a crisis, patients show symptoms such as elevated blood pressure, skin blotching, and violent vomiting [5,6].

Although the oral and dental manifestations of FD are less prominent than the systemic characteristics of the disease and, unlike the systemic symptoms, are not life-threatening, the oral and dental symptoms are, nonetheless, an important aspect of the disease. Some distinctive orofacial characteristics, such as small jaws and dental crowding, are unique to those with FD [1,3]. In addition, patients with FD lack fungiform papillae (structures that house taste buds) on the tongue, often a diagnostic symptom of FD [5]. As a result of their poor appetites, as well as difficulties with sucking and swallowing, FD patients often suffer from inadequate nutrition. To increase their intake of nutrients, many patients undergo gastrostomy (a surgical insertion of a feeding tube), so that the nutrients enter directly into the stomach without passing through the mouth. FD patients also experience chronic gingivitis, at least partly attributable to plaque accumulation and to poor oral hygiene. Finally, due to the patients' low sensitivity to pain, many injuries, such as fractures and burns, go unnoticed, patients also undergoing dental trauma and orodental self-mutilation. [1]. Thus, dental problems among FD sufferers result directly from intrinsic complications within an FD patient's system, and indirectly from non-dental effects of the disease such as the lim-

ited ability of FD individuals to feel pain.

FD is a genetic, congenital disorder, and, like many genetic disorders, it stems from a splicing error caused, in this case, by a nucleotide mutation on the IKBKAP gene. The splicing error removes a portion of the transcript which is normally translated into a protein, while introducing an early stop codon into the transcript, thereby terminating translation prematurely. The human elongator complex, of which the IKAP protein is a part, is thereby compromised, bringing about many of the observed neurological dysfunctions in FD patients. The neurological problems of FD are caused by a failure of sensory and autonomic neurons to develop and survive, likely explaining their diminished sensitivity to pain as well as their unsteady gait [5].

Many FD sufferers have serious dental problems, but it is not clear to what extent these dental problems result from genetic disorders associated with FD or from non-genetic factors associated with the disease.

Genetic disorders may also affect tooth development, which occurs from the 6th to 8th week in utero until an individual is a year old. An embryo is made up of three primary germ-cell layers, the mesoderm, endoderm, and ectoderm. The ectoderm cells go on to differentiate into cells of the nervous system, the epidermis, and tooth enamel. Dysfunction of the neural crest, which is part of the ectoderm, is thought to lead to the dysautonomic problems in FD patients. Because the neural crest also plays a role in tooth formation, FD tends to be associated with dental abnormalities [3].

In fact, many FD sufferers have serious dental problems, but it is not clear to what extent these dental problems result from genetic disorders associated with FD or from non-genetic factors associated with the disease. As noted above, dental problems can occur because of the patient's impaired sensitivity to pain, often resulting in oro-dental self-mutilation. Self-mutilation in-

volves behavior that results in self-inflicted tissue damage. Such behavior, for example tongue biting and self-extraction of teeth, frequently occurs in the oral cavity. But in a 2004 study, Gadoth and Mass observed that self-mutilation is not just the result of insensitivity to pain, it may also be due to feelings of depression or self-destructive urges [2].

A 2010 study by Zilberman *et. al.* examined the primary molars of FD patients to gain insight into the trauma experienced in their first year of life. The study utilized the fact that subjecting teeth to great enough stress, actually leaves an imprint on the tooth enamel. Indications of trauma were found in the enamel of 100% of the molars of the FD children and in only one of the healthy children. This finding supports the hypothesis that infants with FD experience frequent episodes of traumatic stress in the first year of life and that much of their dental problems are non-genetic [6].

To obtain information about the actual treatment of the dental pathologies of an FD patient, Dr. Edward A. Stein, an endodontist in the Atlanta Georgia area, was interviewed. Dr. Stein has treated a 15-year old patient with FD, who presented a unique situation in which the dentin of the upper central tooth had begun to wear away. This process is known as internal resorption. This case of resorption was diagnosed by a pedodontist during a general exam, the patient being unaware of the condition, because of impaired sensitivity to pain. If left untreated, the tooth would have broken down from the inside out. Even if treated, resorption may only be slowed down, not permanently stopped. The treatment of choice for the patient was endodontic and restorative therapy, involving a root canal and inserting filling material where the tooth had broken down from the inside. While local anesthesia is not absolutely indicated in dental procedures with patients with FD due to their inability to feel discomfort, local anesthesia was performed as a precaution. One year later, the patient still has the tooth.

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This article is dedicated to my dear friend Melanie Cohen, whose sweet smile is just one of many endearing qualities, and to her parents, Dana and Gary Cohen, good friends to me and my family.

There is no cure for FD. While genetic testing is now available to prevent future cases of FD, the question remains as to how those suffering with FD should be treated. Researchers in the Laboratory for FD Research at Fordham University, led by Dr. B. Rubin and Dr. S. Anderson, discovered that while the patients are producing the mutated form of the transcript, they are also producing, to a small extent, the full-length transcript, leading to the production of the full-length, functional IKAP protein. Research has led to the use of nutritional supplements that promote the production of the full-length protein. In 2003, Dr. Anderson and co-workers discovered that tocotrienol, a form of vitamin E, can help increase the production of the correctly spliced transcript. In addition, a component of green tea, known as epigallocatechin gallate (EGCG), was found to alter the splicing process, thereby producing the correctly spliced transcript and increasing the full length IKAP protein in FD individuals [5].

Aside from taking tocotrienol and green tea, which has improved the lives of many FD individuals, increased attention to dental health can also enhance the quality of life of FD sufferers, especially because their overwhelming medical needs often result in the neglect of their dental health. Not only does poor dental health cause great discomfort, which can have immediate adverse consequences on overall health, neglecting dental health can also damage a person's self-image, which is already poor among many FD sufferers. As mentioned earlier, FD patients often suffer from oro-dental self-mutilation, likely resulting from depression and low self-esteem, and not only from impaired pain perception. When treating any patient, one must try to understand him or her as a whole person made up of interrelated sides and challenges that cannot be treated in isolation. The dental aspects of FD are important not only because they add to the physical distress of the patient, but because dental treatment may address not just a single symptom but may provide a vehicle for improving the patient's overall well being and health. ■

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GENDER ASSIGNMENT: A DELICATE MATTER

Michelle Haimowitz

Throughout history, society has created a binary gender system in which people are typically classified as distinctly masculine or feminine. For the most part, human beings have been able to fit neatly into these two categories, and there has been little objection to this system. It is no surprise, then, that *halacha* has similarly adhered to a binary gender system, differentiating men and women's *halachic* obligations. However, for as long as these gender categories have existed, so have deviations from the norm. An androgynous, for example, one with ambiguous genitalia, defies the classic binary gender system. There is a history of androgynous people dating back to many ancient and pre-modern cultures. For instance, in the *Symposium*, Plato mentioned the idea of androgyny. He wrote about the creation of mankind as having started out with one sex and then separated into two. Despite the distinction between sexes, Plato often imagined all human souls as androgynous, or hermaphroditic, in their perfected nature [1]. Unlike Plato's view of hermaphrodites as the image of perfection, *Halacha*, along with much of society, views intersexuals as abnormal. Rabbinic literature offers guidelines on the *halachic* status of intersexuals.

Halacha divides those with unassigned gender into two broad categories: the androgynous (hermaphrodite) and the *tumtum*. The hermaphrodite, as defined by *halacha*, is a person who has both female and male genitalia, while the *tumtum*, according to *halacha*, is a person who has a flap over his genitalia which prevents the gender of the person from being ascertained. According to rabbinic literature, there are five possible gender categories by which an individual can be classified: male, female, part male and part female, *safek* (unsure of the gender), or *berya bifnei atzma* (a unique creature with its own characteristics) [2]. Most *rishonim* and *poskim* maintain that the hermaphrodite has a status of *safek* since neat classification of such an individual as male or female is difficult. Because of this doubt, the strictest opinion within *halacha* is to be followed. Thus, according to the *Rambam* and the *Shulchan Orech*, a hermaphrodite would be required to keep all laws pertaining to both males and females. Many, however, argue that the hermaphrodite has the status of a "certain male" and should thus be obligated to comply with the *halachic* standards set forth for a

male [4]. In the case of a *tumtum*, however, normative *psak* maintains that he is considered a *safek* unless the covering is successfully removed such that the person's gender can be ascertained. If the gender is successfully determined, the *tumtum* is considered a qualified member of its respective gender [2].

The proper halachic response to bearing a child of uncertain gender is equally unclear. Until recently, a common practice in the medical field has been to immediately assign a specific gender, usually female, to the child after birth and then perform the appropriate surgery that follows that assignment.

The proper *halachic* response to bearing a child of uncertain gender is equally unclear. Until recently, a common practice in the medical field has been to immediately assign a specific gender, usually female, to the child after birth and then perform the appropriate surgery that follows that assignment [4]. However, within rabbinic literature, the issue of assigning a gender has become particularly complex. According to the *Rambam*, R. Waldenberg, R. Asher Weiss, and R. Bleich, one should determine a child's gender based on the child's external sexual organs [2]. However, according to Rav Sternbuch, a child with ambiguous sexual indicia should always be surgically turned into a male [2]. The reason for this is that there are many *halachic* issues with assigning a female gender to this child. One of these problems is that the child would be prevented from performing certain *mitzvos* if classified as female. The only exception to this rule would be if the child in question has obvious external female organs, in which case the child would be classified as female [2].

Even with these *halachic* guidelines, many complications arise due to recent findings on the topic. None of the earlier *poskim*

considered genetics when determining the gender of the child, since there was little known about this field. Recent technological advancements have allowed for genetic testing in which one can determine whether the child has an XY sex chromosome pair (male) or an XX sex chromosome pair (female). This factor, although not mentioned by many of the major *poskim* due to the lack of information that was available to them, can prove very useful in determining the gender of a child. Furthermore, it has become apparent that although one can assign a gender by surgically changing a child into a male or female and raising the child as such, the assigned gender does not always psychologically resonate with the child. For instance, there was a case reported in *Newsweek* in 1997 of a boy who, due to a terrible accident that involved mutilation to his genital area during a routine circumcision in a hospital, was reassigned a female gender at eight months old. Despite surgery, hormone administration, and his cultural female upbringing, the boy psychologically felt masculine. He had always considered himself a “freak” until he learned the truth about his

gender status and prior condition. As a result, he had his breasts removed and his genitals rebuilt and reverted back to his original gender [4]. This case shows that a person’s gender cannot be randomly assigned and is not only determined by social surroundings; gender is partially inherent within a person. It is important that a person psychologically feels comfortable within his assigned gender in order for gender assignment to be a success.

The issue of gender assignment in intersexual children has no clear-cut procedure. Although *poskim* have set forth some guidelines to determine how to handle the situation, it is clear that an assessment must be made on a case-by-case basis [3]. The application of traditional *halacha* to the continual advancement of medical technology has become increasingly difficult and complex. It is the job of the rabbinic authority to examine the issue of ambiguous gender as a whole, both its *halachic* precedents and the surge of new scientific information that is gathered each year, in order to determine the direction in which *halacha* will go in regard to this delicate matter. ■

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SMALL STORMS, BIG EFFECTS

Ilana Ickow

You are on a cruise, spending your days enjoying tender prime rib, tanning on the ship's sun-drenched deck, and playing competitive games of ping-pong in one of the arcades. As you stroll to breakfast one clear, sunny morning, a drop of water falls on your head. Dismissing it as mist from the ocean, you walk on, following your nose towards the scent of fresh fruit and frying omelets. Suddenly, the wind begins to howl, the skies open up, and gigantic drops of rain pour down, soaking all the passengers on the ship's deck. As you dash towards the dining room, you are thrown to and fro as the boat rocks in the stormy seas. The captain's call for passengers to evacuate the deck is muffled by rumbles of thunder, and safety lights are overpowered by flashes of lightning.

After finally reaching the dining room, you peer out one of the windows. Between monstrous waves splashing against the glass, you catch a glimpse of the sea and are shocked by what you find. A short distance away, the waters are calm, the sun is shining, and other ships are proceeding peacefully on course.

The prophet *Yonah* experienced a similar phenomenon. He left Israel to "run from before G-d" and boarded a ship heading to *Tarshish* (*Yonah* 1:3). However, *Yonah* never reached *Tarshish*, since G-d sent "*ruach gedola el hayam*," "a great wind to the sea," which resulted in a "*sa'ar gadol bayam*," "a great storm in the sea" (*Yonah* 1:4). The passengers subsequently cast lots to determine "*b'shelmi hara'ah hazot*," "because of whom did this bad occur?" (*Yonah* 1:7). The lots revealed that *Yonah* was the culprit, so the passengers, observing that the seas grew stormier, tossed *Yonah* overboard. The *Radak* (*Yonah* 1:7) asked an obvious question: Why did the travelers assume that the storm raged as a result of one of the travelers on their boat? Weren't other boats on the sea also suffering? The *Radak* quoted *Pirkei D'Rabbi Eliezer* who related that when passengers on *Yonah's* boat looked to their right and left, they saw other boats floating peacefully. Only one boat was engulfed by the storm - *Yonah's*.

Similarly, at *Matan Torah*, the giving of the Torah, in the Sinai Desert, the Torah describes the scene, "*Vayehi kolos u'vrakim v'anan kaved al habar*," "There was thunder and lightning, and a heavy cloud on the mountain" (*Shemos* 19:16). This storm, similar to

that in the book of *Yonah*, occurred over so small a width that it was concentrated only over one mountain. In this case, however, the storm occurred in a desert and not at sea.

Is it possible to explain these localized storms described in *Yonah* and *Shemos b'derech hateva*, according to the laws of nature?

Is it possible to explain these localized storms described in *Yonah* and *Shemos b'derech hateva*, according to the laws of nature? Yes, these storms may well have been microbursts, local storms generally less than one mile in width [1] and consisting of winds over 100 mph [2]. A microburst is a small but powerful storm that develops in three stages: In the first stage, the contact stage, air is forced downward from the clouds, accelerates, and reaches the ground. In the second stage, the outburst stage, the wind, after reaching the ground, diverges and curls outward. In the last stage, the cushion stage, these diverging wind gusts decelerate as a result of friction with the ground. This slowing of the winds as they move away from the microburst may explain why microbursts are confined to a very small area. The winds of a microburst are extremely dangerous due to their unexpected and rapid development and extraordinary speed. Additionally, the divergent air creates a vortex, or horizontal spiral of wind, powerful enough even to uproot trees much like a tornado [3].

Microbursts form through a mechanism called evaporative cooling. In this process, hot air rises, cools as it rises, and condenses into clouds. As the clouds become saturated, rain begins to fall. As rain falls from the clouds, it travels through drier air. The drier air causes some of the rain to evaporate, absorbing heat from the air and cooling it. The cool air is denser than warmer air, so it falls, accelerating until it reaches the ground. During the contact stage of a microburst, this downward air, called a downburst, eventually hits the ground. After reaching the ground, the outburst stage begins when the downburst diverges horizontally

in all directions and forms strong wind gusts. The formation of these gusts is a major characteristic of a microburst [2, 3]. Since the initial rising hot air ascends because hot air is less dense than cooler air, a temperature difference between the warmer air near the surface and cooler upper air is necessary for hot air to rise in the initiation of a microburst. Therefore, a larger difference between the temperature at the ground and temperature above is more likely than a smaller temperature difference to result in a microburst [4]. Atkins and Wakimoto analyzed microbursts in Alabama and found that when microbursts occurred, there was always a temperature difference of at least 20°C [3].

Several descriptions of the storms in *Shemos* and *Yonah* seem to indicate that microbursts were present. The storm in *Yonah* is described by its “great wind,” which is a characteristic feature of a microburst. Furthermore, the mention of the cloud at *Matan Torah* also is indicative of a microburst. Since the repetitive ascent, cooling, and descent of warm air - a process similar to microburst formation and requiring similar conditions - generates substantial electricity to form a thunderstorm, microbursts are often accompanied by thunderstorms [3]. The storm at *Matan Torah* was perhaps a microburst combined with a thunderstorm, as the verse clearly states that thunder and lightning were present.

Matan Torah took place in a dry desert, where microbursts sometimes do occur. However, microbursts are much more commonly found in humid environments, such as over water, as in the story of *Yonah*. In areas with high levels of humidity, there

is more moisture to evaporate and cool the air, and the greater degree of evaporative cooling is more likely to form a microburst [3].

Microbursts did not only pose a danger to ships travelling at sea thousands of years ago, but they also threaten the safety of airplane travel today. During takeoff and landing, tailwinds (winds moving in the same direction as an airplane) generated by the microburst during the outburst stage cause the aircraft's airspeed (airplane's speed relative to the surrounding air) to diminish [1]. Sufficient airspeed is critical to flight, since the lift of an aircraft is proportional to the square of the airspeed [5]. The reduction in airspeed causes the plane to lose lift and descend. If the plane is close to the ground, such as during takeoff and landing, there is often not enough time available to recover from this loss of altitude, and the aircraft may crash. Additionally, the downburst also contributes to the airplane's loss of altitude, although not as significantly as the tailwind [1]. Several flights have unfortunately had fatal accidents due to microbursts, including a Pan American flight in 1982 that took off from New Orleans and crashed during takeoff in an undetected microburst [3].

Such an explanation of the miracles of *Matan Torah* and *Yonah* does not make them any less wondrous. That a microburst could cause a storm on *Yonah's* ship as he fled from before G-d, and that a narrow storm formed on Mount Sinai as the Torah was being given to the Jewish people is most certainly phenomenal. ■

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TAHARAT HAMISHPACHA: ITS POTENTIAL IMPACT ON FERTILITY

Jennifer Lazaros

Taharat hamishpacha is a fundamental area of Jewish law that serves to bring *tabara*, or purity, to the Jewish family. It is the Jewish woman who bears much of the responsibility to maintain this purity, as it is upon her to ensure that no uterine blood is discharged prior to engaging in coitus with her spouse. While Sarah, the first of the Jewish matriarchs, was alive, a cloud would be continuously stationed over her tent (*Rashi, Bereishis 24:67*). The *Maharal* explained that the cloud that hovered over Sarah's tent was analogous to the clouds of glory that hovered over the *mishkahn*, or tabernacle, which served as the earthly manifestation of the *Shechina*, or Divine Presence. Sarah merited this extraordinary honor due to her fastidious observance of the laws of *tabarat hamishpacha* (*Netzach Yisrael* Ch. 54). Thus, it is through today's scrupulous observance of the laws of family purity that the children of Israel merit to have the Divine Presence dwell in their homes [8]. Unfortunately, although the laws of *Tabarat hamishpach* serve to elevate the Jewish home to awesome spiritual heights, in certain instances, their observance may cause a woman to have difficulty conceiving and bring about additional challenges in coping with gynecological abnormalities, such as endometriosis.

The Bible states "you shall not approach a woman in her time of unclean separation to uncover her nakedness" (*Vayikra 18:19*). *Niddab* is a state during which a Jewish woman must separate from her husband, as she is considered to be *halachically* impure. Most commonly, the *niddab* status is typically brought about by menstruation but can be brought about by the emission of uterine blood, including bleeding due to hormonal contraception, ovulation, ante-partum, intra-partum, and post-partum bleeding, and due to pathologies, such as endometriosis. If the cervix is opened to a certain extent, which can occur during certain gynecological procedures, even in the absence of bleeding, a woman might be considered to be in a state of *niddab*. Intercourse is also forbidden on days during which a woman anticipates her menses, known as *onot perisha*, or "days of separation." Additionally, if a woman experiences a consistent physical symptom indicating the onset of her menses, termed a *veset baguf*, she is forbidden to engage in coitus [4].

If a woman becomes a *niddab* due to the onset of her menses, she must wait five days before she can begin a seven-day purification process, regardless of the duration of her bleeding. Upon the conclusion of these five days, the woman examines herself with a white cloth, termed a *bedikah* cloth, to check for blood. If she is clean, she begins counting seven clean days. However, if she finds blood, she must wait until her flow ceases to perform the

It is imperative that an Orthodox Jewish woman suffering from either religious infertility or endometriosis consults a competent rabbinic authority with regard to the course of action to pursue.

examination again and begin counting the seven clean days. During the seven clean days, a woman performs two examinations per day and is required to wear white undergarments so that she can be absolutely certain that no blood has been discharged. At the conclusion of these seven days, a woman immerses in a *mikvah*, or ritual bath. It is only upon the completion of this process that a woman may resume coital activity with her husband [2].

Although the observance of the laws of *niddab* can be quite challenging, studies have demonstrated that those who refrain from coitus during menses are generally at a lower risk for contracting certain sexually transmitted diseases and certain gynecological disorders, such as endometriosis. Symptoms of chlamydial and gonococcal salpingitis are more prevalent in women within 7 days from the onset of menses than during the 7 to 14 days following menses. The higher incidence of these infections during menses could be attributed to the presence of iron in menstrual blood. Iron is important for the growth of gonococcal bacteria and would potentiate the risk of infection. Additionally, the premenstrual peak of estrogen and progesterone facilitates chlamydial infection [1].

Engaging in coitus during menses with a partner who has human immunodeficiency virus (HIV) can also increase the risk of

transmitting the infection; this is most probably because during menses, a woman's cervix secretes cells that are capable of hosting HIV. Additionally, because a woman's cervix widens during menstruation, her uterine wall is more vulnerable to contamination by infectious seminal fluid. In addition to being more susceptible to certain sexually transmitted diseases (STDs), engaging in coitus during menses can increase a woman's risk of developing endometriosis, a pathological condition in which a woman suffers from ectopic deposits of endometrial tissue lodged most commonly in the pelvic cavity, but also in other areas of the body. The increased prevalence of endometriosis among women who engage in coitus while menstruating is attributed to the increase in retrograde flow of menstrual discharge during orgasm [1].

Jewish law mandates that a couple have children, as it states in the Bible, "be fruitful and multiply" (*Bereishis*: 1:28, 9:1-7, 35:11). In general, Judaism attaches great importance to marriage and family life to the extent that a wedding party has the right of way over a hearse. Although Judaism does attribute great importance to the social aspect of marriage, the main reason for matrimony is procreation [3]. Despite the import granted to procreation, a woman must strictly adhere to the laws of *niddah* and cannot engage in coitus with her husband until she has properly completed the purification process and immersed in the *mikvah*, even if this were to decrease a couple's chances of conceiving.

Orthodox Jewish women who ovulate at an earlier point during their cycles are likely to experience difficulty conceiving. Vollman (1977) used rises in basal body temperature (BBT) to calculate the duration of postmenstrual phases of cycles of differing lengths. A rise in a woman's BBT is thought to occur 1-2 days following ovulation. Thus, Vollman's "postmenstrual phase" is defined as the interval from the onset of menstruation through ovulation or one day post-ovulation [2].

Vollman found that 22.4% of women complete the postmenstrual phase in 14 days or fewer (However, Vollman's figures were slightly inappropriate because they are based on a sample of women between the ages of 11 and 55. A more accurate estimate could be derived from applying his observations to women in their key reproductive years). Since most Orthodox Jewish women complete the *niddah* period and attend the *mikvah* on or before day 14 of the postmenstrual phase, then according to Vollman, only 22.4% of women would potentially experience reduced fecundability due to the observance of *tabarat hamishpacha* [2]. This would mean that the majority of women are potentially exposed to coital activity during a fertile period even when sexual relations are not resumed until the 14th day of their cycle. In fact, for the majority of cycles where the end of the *niddah* period coincides

with a highly fertile period, the increased likelihood of coitus shortly after a woman's immersion in the *mikvah* could potentially enhance fertility.

Recently, new treatments have been developed to delay ovulation in Orthodox Jewish women who ovulate prior to the completion of the *tabarah* process. Speroff *et al.* (1999) prescribed clomiphene citrate be taken on day 7 or 8 of a woman's cycle, with ovulation expected to occur 5-10 days after the last day the medication is taken [6]. Clomiphene citrate, a selective estrogen receptor modulator, interferes with estrogen feedback to stimulate the luteinizing hormone (LH) surge that triggers ovulation. As a woman's follicles mature during the follicular phase of her cycle, they produce estrogen. Eventually, the follicle destined to become the dominant follicle matures and secretes increasing amounts of estrogen, which exhibits positive feedback on LH, generating the dramatic pre-ovulatory LH surge [9]. High levels of LH cause the follicle to swell and rupture; the oocyte is expelled and is viable for about 24 hours. Without estrogen feedback at this precise point in a woman's cycle, ovulation will not be induced. Although clomiphene citrate can be used to delay ovulation, it is associated with a 5-10% risk of multiple gestations and can cause an atrophic endometrium and hostile cervical mucus, which sperm have difficulty penetrating [5].

Yairi-Oron *et al.* (2006) devised a different treatment to resolve the dilemma faced by Orthodox Jewish women ovulating prior to ritual immersion. Estrogen was administered on the second day of menstruation until the first two clean days to 26 patients attending clinics for the treatment of religious infertility, diagnosed on the basis of findings of a prolonged menstrual flow or a short follicular phase with ovulation occurring during the 7 clean days before the ritual bath. Patients were given 4 mg of beta estradiol. The characteristics of each patient's menstrual cycle with and without treatment were compared. The number of days of bleeding decreased after estrogen therapy and patients attended the ritual bath after a significantly shorter period; patients also ovulated at a significantly later point during their cycle. Prior to treatment, patients ovulated 0 to 5 days before attending the ritual bath whereas with estrogen therapy, they ovulated 2 to 10 days after the ritual bath. Estrogen treatment resulted in a 23% pregnancy rate per cycle, which is similar to the natural conception rate in the normal, fertile population [6]. The positive findings of this study are in agreement with the findings of Ziegler *et al.* (1991) that exogenous estrogen may inhibit follicular growth for up to 2 weeks after the onset of the last menstrual period [7].

In addition to its potential to diminish the likelihood of conception, the observance of *tabarat hamishpacha* can also greatly

magnify the anxiety of Orthodox Jewish women suffering from endometriosis. Endometriosis is a chronic pathology characterized by ectopic deposits of endometrial glands and stroma outside of the uterus. Women with endometriosis may experience premenstrual bleeding, staining, or pelvic pain, as well as various other physical sensations [4]. Many of these symptoms are due to displaced endometrial tissue acting as it normally would-thickening, breaking down, and bleeding- with every menstrual cycle. Surrounding tissue can become irritated and scar tissue may develop [10]. Interestingly, studies have shown that endometriosis is less prevalent among women who observe *tabarat hamishpacha*. However, the symptoms of endometriosis pose unique and difficult consequences for those Orthodox Jewish women who unfortunately struggle with the condition.

Endometriosis can cause premenstrual spotting as well as inter-menstrual bleeding. In either of these cases, although the woman technically is not menstruating, this blood might very well render her a *niddah*, if of a certain quantity and if observed on a white garment. This could potentially detract from the already limited time that an Orthodox Jewish couple has to engage in marital relations. If a woman with endometriosis were to experience irregular bleeding during her seven clean days, she would most likely be obliged to begin her counting of the seven clean days anew, further delaying reunification with her husband. Although irregular spotting and bleeding might not be particularly significant to non-Jewish or non-observant women, these symptoms can have extremely adverse consequences for an Orthodox Jewish woman.

In addition to irregular spotting and bleeding, a woman with endometriosis might experience pelvic pain. Because pelvic pain

is typically experienced prior to menstruation by even normal women, an Orthodox Jewish woman suffering from endometriosis might be apt to confuse the pelvic pain caused by her condition with a *veset baguf*, or symptom indicating the onset of her period, which would necessitate that she separate from her husband [4]. Furthermore, if a woman has endometrial deposits in her vaginal canal, she might aggravate the tissue while performing a *bedikah*, resulting in her rendering an unclean examination. If she cannot be certain that this blood is not uterine blood, then she may be required to begin counting her seven clean days anew.

It is imperative that an Orthodox Jewish woman suffering from either religious infertility or endometriosis consults a competent rabbinic authority with regard to the course of action to pursue. A Rabbi might allow a woman with endometriosis, for example, to take birth control pills to reduce her bleeding or to wear dark underwear to avoid seeing irregular spotting. It is important that the woman be informed of the available *halakhic* courses of action, in addition to seeking medical treatment. It is also advisable that she see a physician who can understand and be respectful of the requirements of Jewish law while treating her. An Orthodox Jewish woman might need to avoid scheduling diagnostic procedures, for example, during her seven clean days or the few days prior to the onset of her period to avoid having to attribute any blood that might result from the procedure to her menses [4]. Additionally, certain clinical symptoms of endometriosis, such as spotting, might be insignificant to a physician but can be extremely significant to an Orthodox Jewish woman and must be addressed. Together the advice of both physicians and rabbinic authorities can aid Orthodox Jewish women in observing the laws of *tabarat hamishpacha* with greater ease and serenity. ■

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MODERN MIRACLES: SURGERY IN THE TALMUD AND TODAY

Rikah Lerer

In September of 1977, Siamese twins joined in the ventral area from the shoulder to the pelvic region were born to an orthodox Jewish family from Lakewood, New Jersey. The children, Baby A and Baby B, shared a six-chambered heart and a conjoined liver. After much extensive medical testing and examination, it was determined that Baby A could not survive no matter what surgical measures were taken, and if no surgery was performed, the two would die. Dr. Koop, the chief of surgery at the time in the Children's Hospital of Philadelphia, recommended that the twins be separated as soon as possible because the heart could not maintain the blood flow to the two infants. Even with surgery there was a large chance that neither baby could be saved. On October 6, Rav Moshe Feinstein made his decision and instructed Dr. Koop to go ahead with the surgery. On October 11, the surgery was completed and Baby B and Baby A were separated; only Baby B survived [1].

The above case is just one example of the medical and surgical capabilities we have nowadays. The ability to separate two human beings successfully demonstrates the tremendous potential that humans have in the surgical field. The phenomenon of surgery gives us the possibility to choose one life over another, recreate and reconstruct, to save lives and to enhance them. It seemingly would not be so unusual to compare surgeons, albeit on a smaller scale, to

G-d, who creates and sustains, gives life and takes it away. In Judaism, it is important to understand the role of doctors and their permission to intervene. We have the physical tools to alter a person's life, and we are permitted to use them. The Talmud learns from the double language of the *pasuk*, “*V'rapo Yirapei*,” (and he shall heal), that a doctor is allowed to heal and a person is allowed to go to a doctor to be healed (*Shemos* 21:19). *Rashi* comments that even when a person becomes ill by *Hashem's* decree, he is allowed to go to a doctor and should not rely solely on faith in *Hashem* to heal him (*Bava Kama* 85a).

Surgery has a long history of development and advancement. It was not always possible to separate Siamese twins in an operating room. In ancient Greece, surgery was considered a handicraft and was not performed by physicians. It was considered lowly

work that barbers and bath attendants engaged in. When anatomy, physiology and microbiology were recognized as scientific areas of study, surgery began to develop as an accepted practice for physicians. In the 19th century, when anesthesia and methods to avoid surgical infection were recognized, modern surgery became even more advanced [2].

As Jews, we value every moment of life as a precious entity of time during which we can perform mitzvot and become close to Hashem.

If we look in the Talmud, there are a few references to medical cases that required invasive surgery long before surgery became modernized and developed. The main surgical procedures cited in the Talmud include bloodletting, circumcision, neurosurgery, abdominal surgery to remove fat, gynecologic surgery, splenectomy, episiotomy during childbirth, and the removal of putrefied flesh by excision with a knife [2]. All of these procedures involved risks and endangered the patient's life. Additionally, reference was made to a physician bandaging a leg wound and cutting some flesh away to heal a patient. Lepers in Jerusalem went to physicians to remove dead flesh or limbs. Furthermore, various types of surgical instruments are mentioned in the Talmud such as a drill for brain surgery, circumcision knives, knives for performing post-mortem cesarean section, and a scalpel to cut off diseased skin [2].

In Talmudic times, the surgeon wore a leather apron to protect himself from blood splatters, strapped the patient to the table and used his knife and other instruments that were kept in a box [3]. A specific case of abdominal surgery is mentioned about Rabbi Eleazar and Rabbi Ishmael, who were both so obese that when they stood waist to waist, a yoke of an ox could pass below them. Rabbi Eleazar was taken into a marble room and given a sleeping potion. His abdomen was cut open to remove “basketfuls of fat” (*Baba Metz'ia* 83b). Yet another surgical procedure was mentioned about the runners of *Adonijah*, who had their spleens

removed because of the thought that it would hinder fast runners [4]. Furthermore, post mortem cesarean section is discussed in the Talmud when discussing saving an unborn child even on Shabbat (*Arachin* 7a). The term for cesarean section is *yotzeb do-pben* and is described in Talmudic commentators as a situation in which a woman's abdomen is opened by a knife. The Talmud also discusses surgical procedures done to amputate a limb of a leper [3].

In addition to the above cases, the Talmud describes in depth a type of cranial surgery performed to remove a type of growth referred to as *ra'atan* that rests on the meninges (*Kesubos* 77b). The person afflicted with this malady had symptoms of "his eyes tear, his nostrils run, he brings spittle from his mouth, and flies swarm around him" [5]. As a cure, Abaye said,

"Take the following ingredients: Pennyroyal and wormwood bark of a nut tree and the shavings of a hide, a lily, and the calyxes that cover red dates, and boil them together. Then take the patient into a house made of marble (where there is no draft). Then pour 300 cups of this potion on his head until the surface of his skull softens. Then tear open his skull to expose the organism on the membrane. Bring four myrtle leaves, lift up each and insert one leaf underneath. Remove it entirely with tongs and burn it..." [5].

In this *gemara*, the surgical procedure appears to parallel the overall process of modern day surgery: prepare the anesthesia, check that the operating room is clean and sterile, sedate the patient, and begin cutting to remove the growth completely. While utilization of anesthesia and sterilization are thought of as relatively recent in the scope of how long surgical procedures have been carried out, a primitive form of these aspects of surgery can be found dating back to the Talmud nearly 2000 years earlier [5].

Now that the surgical procedures in the Talmud have been outlined, two categories of modern day surgery and their halakhic implications need to be discussed, as well. Risky surgery and cosmetic surgery both pose problems for much of our fundamental beliefs and commandments. As Jews, we value every moment of life as a precious entity of time during which we can perform *mitzvot* and become close to *Hashem*. Anything that would risk this opportunity or diminish it should seemingly be forbidden. It would appear questionable to undergo risky surgery because although it could save one's life, it could also end it early. In the Talmud, Rabbi Yochanan said that one should not have an ordinary *nochri* (non-Jew) treat him for a fatal illness, because of the concern that the *nochri* might kill him (*Avodah Zara* 27b). However, if one is certain that he will die soon unless he is cured of the illness, he may let a *nochri* treat him. The Talmud questioned why treat-

ment at the hands of a non-Jew was permitted in this case at all. By allowing the *nochri* to treat him, he may be sacrificing even the little amount of life he has left. The Talmud answered that since without the treatment, he will only have *chayei sha'ab* (momentary life), and if the treatment was successful he may gain many years of life, he may ignore the possibility that the *nochri* might kill him. Based on this *gemara*, the *poskim* permitted one to undergo a risky surgery. Despite the fact that a risky operation may cause one's death sooner, there is reason to permit this surgery when it is clear that the patient will die anyway. All of the *poskim* emphasize that this is only permitted after both *poskim* and medical experts have been consulted [6].

The second controversial area of surgery is cosmetic plastic surgery. Cosmetic surgery gives people the power to change the way *Hashem* created them and requires one to put one's life at risk in order to beautify him or herself. For these reasons, some rabbis ruled that it is forbidden under all circumstances for men and women to undergo plastic surgery [7, 8]. We know that it is forbidden for a person to wound himself intentionally or ask someone else to do so (*Baba Kama* 91b). This would be required as part of the surgical procedure in order to alter a physical characteristic.

Under some circumstances, however, plastic surgery is permitted. With regards to the prohibition to wound oneself or someone else, the *Rambam* in the *Mishneh Torah* says that this only holds true for degrading and shameful wounds that have no indication (*Chovel* 5:1). If *pikuach nefesh* is involved, this *issur* can be overridden. Furthermore, surgery done to relieve mental suffering is permitted. If there is good reason for undertaking a danger, the prohibition against endangering oneself does not apply. The small risk of plastic surgery is therefore disregarded to remove pain and suffering [9]. This holds true especially if it is a widely accepted and commonly performed procedure. In regard to the concern of interfering with *Hashem's* will, there is no issue if one is attempting to just improve *Hashem's* creation. It is considered to be "Divinely sanctioned healing" for any treatment that will relieve pain and suffering. Some rabbis are more stringent and only allow plastic surgery for a woman so that she can more easily find her husband, to correct external blemishes which might interfere with *shalom bais* (peace between spouses) or to fix physiological ailments that cause mental pain and suffering. It is more favorable if the plastic surgery can be done under local anesthesia to decrease the endangerment involved. Of course, a *halakhic* opinion from a competent rabbinic authority should be sought for every individual case [2].

The Talmud (*Shabbas* 50b) states that a man may remove

scabs from his body to ease pain but not to enhance his appearance. This seems to implicate that plastic surgery is forbidden because the same way one cannot remove scabs to beautify himself, he shouldn't be able to induce injury to enhance his physical appearance. However, *Tosfos* on this *gemara* raised a concept that is key to determining the underlying issue regarding the permissibility of plastic surgery: "If the only pain that he suffers is that he is embarrassed to walk among people then it is permissible, because there is no greater pain than this" [10]. *Tosfos* established that there is no greater affliction than psychological pain due to embarrassment or shame because of a self-perceived imperfection. It is only when cosmetic surgery is for purely vain purposes that the rabbis are inclined to prohibit the procedure [10].

Many specific cases involving invasive surgery arise nowadays and we use pre-standing *halacha* to determine when it is permissible to perform such surgery or not. In the case of the Siamese twins where the surgeon was forced to sacrifice the life of one baby for the survival of the other, how do we reconcile this with *halacha* and Judaism? One of the fundamental rules of *halacha* is that one life is not to be sacrificed for another. The *gemara* teaches us that one person's blood is not more red than another's, and we cannot actively end one life to save another (*Sanhedrin* 74a). As humans, we do not have the right to evaluate the significance of individual's lives. This stems from the *yebareg v'al yavor* (when one must give up one's life rather than transgress a prohibition) of *shfichus damim*, murder. If a murderer tells a man to kill his friend otherwise he will kill him, the man must die before committing the murder of his friend. We must, therefore, ask, how could Rav Feinstein have allowed for the surgical separation and simultaneous sacrifice of one baby?

The ability to derive answers and halakhic rulings from original texts is a tool and a gift that we always have to use in order to solve ethical and *halakhic* questions that arise.

To develop his answer, Rav Feinstein looked to the *mishnah* in *Ohalos* 7:61 and the Talmud in *Sanhedrin* 72b. *Ohalos* 7:61 noted

that if a woman is in difficulty during childbirth, it is permissible to surgically exterminate the fetus because the mother's life comes first. However, if the head of the fetus has already been delivered, it is forbidden to intervene even to save the mother's life. The fetus has become an infant, an independent viable life. This *Mishnah* taught us that we do not choose to save one life over another. The *gemara* in *Sanhedrin* 72b elaborates on the *mishnah* by asking, "Why should you not sacrifice the infant even though the head has already been presented, since this infant is endangering the life of the mother? Is not the infant, then, a *rodef* (pursuer)? The law of the pursuer should apply, which is to kill the pursuer in order to save the life of the victim" [1]. The Talmud answered: "No, Heaven is the pursuer" [1]. This means that the infant endangering the life of the mother is considered an act of *Hashem*, and, therefore, one may not assume that the fetus is the attacker. We cannot decide to favor either the child or the mother in this fight for life because *Hashem* is the only One who can decide. Rav Feinstein compared the case of the Siamese twins to this conflict of survival between a mother in childbirth and the fetus. It was important to establish that Baby A had no independent ability to survive. She was completely dependent on her sister, who had the circulatory system to support the functioning of the heart and liver. Without the surgical separation, both would die, and, therefore, in *halakhic* terminology we classify the baby that had no chance of independent life as the *rodef*, as if she were threatening the life of her sister [1]. With this analysis, Rav Feinstein was able to conclude that the surgical procedure was indeed within our license to heal.

Similar to the complex case of the separation of the Siamese twins, when considering every decision to undergo invasive surgery, we must remember that everything that happens is, in fact, an act of *Hashem* and our power to heal and create is limited in this world. We have the *Torah* and all of the previous examples in the Talmud to guide us in using our advanced surgical abilities in the most ethical and *halakhic* way. ■

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WELL-DRESSED OR ILL DRESSED: THE HEALTH RISKS AND BENEFITS OF MODEST ATTIRE

Aliza Loshinsky

The Jewish concept of modesty is an important part of our religion. The Talmud taught that the entire Torah was consolidated into three commandments, as it is written (*Mishnah* 6:8), “He Has told you, O man, what is good, and what does the Lord require of you: only to do justice, love deeds of kindness, and to walk modestly with your G-d.” Walking modestly with G-d includes many different behaviors. One way it is manifested is through dress. Women who are strict with this *halacha* are careful to dress in a modest manner, often only exposing their face, neck, and lower arms. Men also adopt a more conservative manner of dress, especially in Ultra-Orthodox communities where the typical garb includes traditional-styled clothing and brimmed hats. This modest way of dressing causes decreased exposure to sunlight. Additionally, indoor studying and scholarly activity is very much encouraged in the Orthodox world, which also decreases sun exposure.

Decreased sunlight exposure can lead to several complications. Sunlight is necessary for the production of vitamin D. Photons of ultraviolet B (UVB) rays are absorbed by dehydrocholesterol in the skin, which is then converted into vitamin D₃. Vitamin D₃ is metabolized in the liver to 25-hydroxyvitamin D₃ and then in the kidneys to 1,25-dihydroxyvitamin D₃, the active form of vitamin D. Since vitamin D assists in the intestinal absorption of calcium, insufficient amounts of vitamin D results in low levels of calcium absorption, leading to a decrease in bone mineral density [1].

Bone mass increases throughout childhood and mid-puberty, stopping around late puberty. Prevention of osteoporosis, a disease characterized by the thinning of bone tissue and loss of bone density, is dependent upon the establishment of an adequate peak bone mass during puberty. If adequate bone mass does not develop at that time, one will have a greatly increased risk for osteoporosis later in life. Vitamin D is essential for the establishment of this peak bone mass [2].

A study was performed to assess whether dress had an effect on the vitamin D levels in Orthodox students living in Israel. The study compared three yeshivas in the same area in Israel. The first, Yeshiva-A, was an Ultra Orthodox yeshiva in which the men were

about 20 years old, wore traditional garb, and engaged in very little outdoor activity. The students from the second yeshiva, Yeshiva-B, were around 33, also dressed in traditional garb, but had regularly scheduled outdoor activities. The third, Yeshiva-C, was an Orthodox program where the average age was around 19 and the students participated in a combined yeshiva/army program. The study found that severe vitamin D deficiency was prevalent among the Ultra Orthodox community of Yeshiva-A. The study found that 100% of students in Yeshiva-A, 91% in Yeshiva-B and 51% in Yeshiva-C were vitamin-D deficient; severe vitamin D deficiency was found in 65% of students in Yeshiva-A, 65% in Yeshiva-B and 12% in Yeshiva-C [3]. These results complemented a study in an Ultra Orthodox community in Brooklyn, in which the bone mineral density (BMD) of Jewish Ultra Orthodox male teenagers was significantly lower than the normative scores for the population. In fact, 27% of the boys from the study had BMD scores that were low enough to warrant a diagnosis of osteoporosis, a disease characterized by a significant loss of bone density [2].

A study in New Zealand found an increased risk of earlier onset of melanoma in areas of the body that are usually covered but were intermittently exposed to sunlight, as opposed to areas of the body that are always exposed to sunlight.

In light of these studies, it is evident that young adult males of the Ultra Orthodox community both in Israel and New York are at high risk of developing osteoporosis due to vitamin D deficiency or low bone mineral density. The studies attributed the deficiency to decreased sunlight exposure, a result of their traditional, modest garb, long hours of indoor studying, and lack of outdoor physical activity. The deficiency in vitamin-D led to decreased absorption of calcium, low bone mineral density, and ultimately osteoporosis [2, 3].

Sunlight can also have harmful effects on the human body, in which case modest attire can have a positive effect on health. Solar ultraviolet (UV) radiation can cause DNA damage to skin cells. If DNA damage is not repaired, deleterious mutations arise that may affect cell growth and regulation, possibly leading to malignant tumors. Melanocytes are cells that produce the pigment melanin, which is responsible for skin and hair color. In malignant melanoma, the melanocytes, adversely affected by UV radiation, have sustained unrepaired DNA damage. This may cause these cells to grow abnormally, and result in a change in the appearance of a mole on the skin or the development of an area of discoloration [4].

A study in Israel showed that Orthodox Jews have a decreased risk of melanoma due to the protective role of their traditional and modest clothing. The study compared the occurrence of malignant melanoma in Orthodox and non-Orthodox Jewish communities in Israel between 1970 and 1982. Comparisons were made between the occurrence of melanoma in two cities on the outskirts of Tel Aviv: Bnei Brak which has a predominantly Orthodox population, and Givatayim which has a predominantly secular population. Two neighborhoods in Jerusalem, one predominantly Orthodox and the other predominantly secular, were also compared. The study found that the incidence of malignant melanoma for Jews of European or American descent was greatly reduced in the Orthodox population in comparison to the secular communities. The low incidence of melanoma in Jews of Asian or African descent precluded them from being compared by religiosity in the study [5].

It is important to note, however, that melanoma still poses a risk despite modest dress. A study in New Zealand found an increased risk of earlier onset of melanoma in areas of the body that are usually covered but were intermittently exposed to sunlight, as opposed to areas of the body that are always exposed to sunlight [6]. For this reason, it is extremely important for Orthodox Jews who follow the *halachic* laws of modest dress to apply sunscreen and take preventative measures against sunlight when

exposing areas that are usually covered.

There is a difference in the way sunlight is absorbed by the skin in both sects of Sephardim, who descend from Asian Middle Eastern and North African Jews, and among Ashkenazim, who descend from European Jews. Sephardim are generally characterized phenotypically by a darker skin pigment than Ashkenazim. People with darker skin pigmentation produce more melanin in their melanocytes. The increased melanin found in darker skinned people absorbs and scatters more energy than that of people with fairer skin. This provides people with darker skin greater protection from the sun's rays [7], which has both positive and negative health benefits. On the one hand, it reduces the incidence of melanoma among Jews of Sephardic descent [5]. On the other hand, however, it also decreases their level of absorption of vitamin D, putting them particularly at risk for osteoporosis. In contrast, Ashkenazim are at a greater risk than Sephardim for developing melanoma, as shown by the study above, but have a lower risk for vitamin D deficiency [8].

Although dressing modestly may put one at greater risk for osteoporosis, it is fortunately a risk that can be easily dealt with once it is identified. Orthodox Jews who dress modestly, especially Ultra Orthodox men, should allow for additional sun exposure; the suggested amount is 5-10 minutes a day, 2 to 3 times per week [1]. It is also suggested that Ultra Orthodox Jewish males should take vitamin D supplements [3]. Additionally, adding vitamin D to dairy products, as is already done in many western countries, may help alleviate vitamin D deficiency in Israel [8].

Care must be taken to protect oneself against UV radiation and harmful sunlight exposure. Thankfully, Orthodox Jews are a step ahead on this account by wearing modest clothes, which reduce harmful sunlight exposure. Additional care can be taken to apply sunscreen even to areas of the body that are seldom exposed to sunlight.

Finally, it is important to realize the obligation and privilege we have as Jews in dressing modestly and to uphold this worthy commandment with joy and appreciation. ■

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A BLESSING FOR HEALTH

Miri Mandelbaum

As a student of biology, my days are filled with the study of the human body. Biology is a fascinating subject, while at the same time quite a complex one. The number of tissues and organs we must identify is intimidating. The task of memorizing the mechanisms and pathways the body uses in its daily activities is daunting.

In the context of a college course, the intricacies of the human body are overwhelming. However, without the pressure of exams, the wondrousness of the human body is astounding and mind-boggling. Each organ system, with all its complexities, is only a small piece of the overall workings of the body. *Yad Hashem* is so clearly evident. It is no wonder that the *Rambam*, in discussing the commandments to love and fear G-d, says that the way to attain these emotions is through the contemplation of nature (*Hilchos Yesodei HaTorah* 2:2).

We have the opportunity to stop and focus on these miracles of nature multiple times each day, when we recite the blessing of *asher yatzar*. *Chazal* instituted this special *bracha* to be said after a person relieves himself. At first, we may tend to overlook or even belittle this “bathroom *bracha*.” However, with proper concentration, this blessing can be a tool to elevate our relationship with G-d, as the *Rambam* described. Every time we use the restroom, we acknowledge the miracle of our health, and thank G-d for this gift. The fact that our bodies work properly, despite the complexities of their functioning, truly is a wonder.

The text of the *asher yatzar* blessing is noted in the Talmud *Berachos* (60b). The blessing begins, “*Baruch...asher yatzar es ha’adam b’chachma*,” “Blessed are You, G-d...who fashioned man with wisdom.” Immediately in the first line of the blessing, we acknowledge G-d’s wisdom in creating the human body. It then continues, “He created within him many openings and cavities. It is obvious and known before Your Throne of Glory that if one of them should rupture or one of them should be blocked, it would be impossible to exist and to stand before You.” The openings of the body are those that have contact with an outside environment, such as the nose and mouth. The cavities are the internal organs, such as the heart and intestines. If any of these were to stop working properly, our bodies would not be able to function

(*Shulchan Aruch, Orach Chaim* 6:1).

The most common case of a cavity being blocked is heart disease, which is the leading cause of human death in the United States. The most prevalent heart disease is coronary heart disease (CHD), which often leads to heart attack [1]. In a healthy person, the arteries provide a path for blood to travel throughout the body, delivering oxygen and other nutrients to the cells. In CHD, plaque builds up in the coronary arteries, which are responsible for supplying the heart with oxygen. Over time, the plaque can rupture, causing blood clots to form. If the clots are large enough, they can completely block blood flow to the heart. Myocardial infarction, commonly known as a heart attack, occurs when heart cells are deprived of oxygen because of the obstructed blood flow, and heart muscle begins to die. With the heart not working properly, consequences can be fatal [2]. This is only one example of a cavity whose proper function is vital to our survival.

The fact that the body exists as a combination of both a physical and a spiritual entity, the two of which cannot naturally exist together, is also a wonder.

Asher yatzar ends by blessing G-d who is “*Rofei chol basar u’maftee la’asos*,” “Who heals all flesh, and acts wondrously.” There are many explanations for what this ending means. The *Shulchan Aruch* noted that our bodies getting rid of waste is in itself a form of healing. If the waste were to remain in the body, it would build up and become very dangerous. According to Rav Shimon Schwab, the phrase, “Who heals all flesh,” praises G-d for maintaining our health. The greatest healing, he said, is the prevention of disease [3]. We are constantly exposed to microbes and viruses, yet most of the time our bodies fight them off without us even noticing.

The words “*umaftee la’asos*” come from *Tebillim* 139:14, “*od’cha al kei noraos nifleisi, niflaim ma’asecha*,” “I thank You because I am awesomely fashioned; wondrous are Your works” [3]. If an in-

flated balloon has the tiniest hole, all the air will escape. The human body, on the other hand, has so many openings, yet the soul miraculously remains inside (*Shulchan Aruch*). The fact that the body exists as a combination of both a physical and a spiritual entity, the two of which cannot naturally exist together, is also a wonder (*Rema*). The *nesbama*, which is called “*chelek Eloka mima’al*,” a piece of G-d Himself, exists in harmony with the sub-standard physical body, which produces and expels waste, and will one day decay itself. This blessing specifies the creation of man, in particular, as being “*b’bachma*,” with wisdom, because he lives this paradox [3].

“*Kol atzmosai tomarna, Hashem mi kamocho!*” “All my limbs proclaim, ‘G-d, who is like You!’” (Psalms 35:10). In this familiar passage, quoted in the *Nishmas* prayer on *Shabbos* and *Yom Tov*, *David HaMelech* praised G-d by means of his physical body. The verse continues, “*matzil ani me’chazak mimenu v’ani v’evyon mi’gozlo*,” “Who saves the poor from one mightier than he, and the poor and the destitute from the one who robs him.” Rav Schwab shed light on the connection between the two halves of this verse. He explained that the “poor and destitute” refer to the smaller organs, while the “one who robs” refers to the larger organs. G-d ensures that all organs are provided with the nutrients they need to function. The more demanding needs of the larger organs do not prevent nutrients from reaching the smaller organs [3]. Our digestive systems are such that they distribute nutrients to each part of the body in exactly the amounts necessary for proper function. The teeth physically crush the food. The food then travels down the esophagus, into the stomach, and then the small intestine, while digestive juices produced by the body chemically break it down. Once in the small intestine, the nutrients are ready to be absorbed into the bloodstream. The lining of the small intestine contains many folds with projections called villi. The villi, in turn, contain fingerlike projections called microvilli. These formations allow for increased surface area for efficient absorption. The nutrients are then passed into the bloodstream. The blood transports these nutrients to the exact places where the body needs them. Carbo-

hydrates are taken to the liver, where they are either used for energy or stored for future use. Proteins are brought to where they are needed to build the structural elements of the cells. Fats and fat-soluble vitamins are brought to storage areas throughout the body. When needed, these nutrients are sent to the appropriate organs through the bloodstream [4].

Unfortunately, it is only at the times when things go wrong that we fully appreciate the gift of health. It is in this vein that R’ Yerucham Levovitz, *mashgiach* of the *Mir Yeshiva* from 1910-1936, used to humorously tell his students that they ought to write home every time they used the restroom to let their parents know that, thank G-d, they are healthy. He recognized the miracles that are constantly taking place in the maintenance of our health [3].

The *bracha* of *asher yatzar* makes us stop and recognize these daily miracles. Dr. Kenneth M. Prager of Columbia University Medical Center described how he came to realize the meaning of this special blessing. He wrote, “It was not until my second year of medical school that I first began to understand the appropriateness of this short prayer. Pathophysiology brought home to me the terrible consequences of even minor aberrations in the structure and function of the human body. At the very least, I began to no longer take for granted the normalcy of my trips to the bathroom. Instead, I started to realize how many things had to operate just right for these minor interruptions of my daily routine to run smoothly. I thought of *Abayei* and his blessing. I recalled my days at *yeshiva* and remembered how silly that sign outside the bathroom had seemed. But after seeing patients whose lives revolved around their dialysis machines, and others with colostomies and urinary catheters, I realized how wise the rabbi had been.” [5]

Many *rabbonim* have said that taking the time to say *asher yatzar* slowly and clearly and focusing on its meaning is a *segulah* for good health [6]. We must recognize G-d as the source of our health and thank Him for the miracles He performs on our behalf daily. With proper thought and *kavanah*, saying *asher yatzar* can be a transformative experience. ■

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MEDICAL MARIJUANA: WHERE DOES JUDAISM STAND?

Hannah Marmor

Jewish medical oaths and the Hippocratic oath parallel each other in their emphasis on the palliative aspect of medical care. In Judaism, the alleviation of pain and suffering is a *mitzvah*. Certain conditions such as migraine headaches, Alzheimer's, muscle spasms, fibromyalgia, arthritic pain, glaucoma, and nausea induced by chemotherapy are alleviated by the use of marijuana. If marijuana is superior to other drugs in treating these conditions, it is crucial that the administering of medical marijuana be *halachically* analyzed [1].

To begin, it is important to analyze some of the evidence found in support of the usage of medical marijuana. Most of the research conducted has involved cannabinoids, which are the best-known active ingredients in marijuana. In 1997, the Office of National Drug Control Policy commissioned the Institute of Medicine (IOM) to weigh the potential risks and benefits of marijuana. In 1999, the IOM concluded that cannabinoids have some potential to relieve pain, control nausea, and increase appetite [2]. Also noted was that cannabinoids probably affect the control of movement and memory, so patients using marijuana should not drive a car. However, its effect on the immune system was not definitive [3]. The IOM also stated that smoking marijuana might be a risk factor in the development of lung disease and certain types of cancer. Marijuana has shown clinical promise for the treatment of symptoms related to glaucoma, nausea and vomiting, analgesia, spasticity, multiple sclerosis, and AIDS [4].

To determine whether or not Judaism allows a physician to prescribe marijuana, different *halachic* concepts must be systematically analyzed and discussed. The first *halachic* aspect that needs to be analyzed with regards to the usage of medical marijuana is the principle of *dina d'malchuta dina* (the law of the land) [1].

Dina d'malchuta dina stipulates that, as Jews, we must abide by the laws of the land in which we live. This means that even if Jewish law permits the distribution of medical marijuana in a state where it is illegal, a Jewish physician would still not be able to use medical marijuana to treat his patients. In other words, we would still be expected to follow the law of the land and be honorable citizens. By being righteous and responsible citizens, we are, in fact, being a light unto the other nations. That being said, people

might think that since marijuana is an illegal drug, its use is *halachically* forbidden as well [1].

Furthermore, Rabbi Moshe Feinstein believed that (with regards to recreational usage) marijuana limits a person's ability to demonstrate free will by altering his or her sense of reality and impairing his or her judgment.

Currently, the usage of medical marijuana has been legalized in sixteen states and in Washington, D.C. These sixteen states include Alaska, Arizona, California, Colorado, Delaware, Hawaii, Maine, Michigan, Montana, Nevada, New Jersey, New Mexico, Oregon, Rhode Island, and Vermont [5]. Despite the legalization of medical marijuana in these states, the United States Supreme Court has ruled that medical necessity does not justify the allocation of marijuana.

However, it is important to realize that *dina d'malchuta dina* applies only to matters of monetary, commercial, or civil law, not to religious law. In areas where the State has a legitimate interest for the smooth functioning of society, *dina d'malchuta dina* applies. This includes taxes, traffic regulation, safety, etc. Laws that impact religious and cultural areas of life, however, are excluded from *dina d'malchuta dina*. Since the alleviation of pain and suffering is a religious law, the concept of *dina d'malchuta dina* does not apply with regards to the use and distribution of medical marijuana.[1].

The next *halachic* analysis of medical marijuana would therefore be to determine the prudence of the physician prescribing the drug. Knowing that the alleviation of pain and suffering is a *mitzvah*, how far must a physician go to alleviate a patient's pain by prescribing medical marijuana? In *Vayikrah* 19:16 it is written, "Neither shalt thou stand idly by the blood of thy neighbor." According to this verse, Jews are commanded not to stand idly by while someone's life is slipping away. *Tosafot* maintained that living with pain is much worse than death itself [1].

The next *halachic* aspect that must be analyzed with regards to medical marijuana is the impact the drug may have on the patient's ability to perform other *mitzvot*. According to the scientific literature, recreational marijuana can cause feelings of euphoria, short-term memory loss, difficulty in completing complex tasks, changes in perception of space and time, as well as the inability to concentrate [2]. Furthermore, Rabbi Moshe Feinstein believed that (with regards to recreational usage) marijuana limits a person's ability to demonstrate free will by altering his or her sense of reality and impairing his or her judgment. Therefore, this person would not be able to act responsibly and fulfill crucial *mitzvot*, such as prayer [1].

This article is not dealing with recreational marijuana, but rather medical marijuana that relieves the symptoms of many health conditions and the pain associated with them. Under Jewish law, the violation of Shabbat is permitted for a seriously ill person, and individuals in even minor discomfort are relieved from other religious obligations. According to Jewish law, there is no genuine distinction between illness and pain. There is, however, friction regarding the extent to which pain justifies exemption from religious law. A minute, localized pain does not warrant any religious exemption. On the other hand, severe pain throughout the entire body that would accompany a real illness warrants exemptions from religious law. According to Rabbi Yair Bachrach, exemptions from religious law are allowed only in cases of severe pain. However, according to Rabbi Chaim Yosef David Azulay, these exemptions are warranted by a person in any amount of pain [1].

This notion of a person's duty to heal is reflective of Judaism's view that the human life is of utmost importance and value. This can be seen by the fact that almost any Jewish law can be violated to save a person's life or prevent a life-threatening situation from occurring [1].

Medical marijuana is used to relieve patients from the symptoms of AIDS and chemotherapy. It is also used to treat glaucoma. Each of these conditions is viewed by Jewish law as being a potentially life-threatening situation. If Shabbat and other laws can be violated in these situations, surely the distribution of the illegal drug marijuana is allowed here as well. Also, assuming no other treatments have worked or are available, marijuana may also be allowed in non life-threatening situations such as migraine headaches. After all, it is a *mitzvah* not just to save a life, but to alleviate pain and suffering as well [1].

The fourth *halachic* aspect that must be taken into consideration with medical marijuana is the idea of self-endangerment. There are a number of potentially dangerous side effects associat-

ed with marijuana, including short term memory loss, difficulty in completing complex tasks, changes in the perception of time and space, anxiety, confusion, low blood pressure, rapid heart beat, and heart palpitations [2]. Most researchers also believe marijuana contains numerous carcinogens (50-70% more than tobacco smoke) [6]. Marijuana can cause a decrease in reproductive function, increase the risk of lung disease, as well as increase the risk for lung, mouth, and tongue cancer [2]. Most recently, marijuana has also been linked to the etiology of many major psychiatric conditions, such as depression and bipolar disorder [7].

While Jewish law prohibits the act of self-endangerment, there are acceptable risks that can be taken when involved with routine activities. For example, driving a car can be a dangerous activity but society has deemed it to be a routine part of life. It is important to realize that all activities have some or another form of risk associated with them. Whether it is taking a subway or walking down stairs, both of these seemingly mundane activities pose some form of a potential risk. The Talmud states that risks which have become socially conventional (e.g., driving a car) are acceptable. *Halacha* dictates that analgesics may be given to a patient even at the risk of possibly shortening his or her life, as long as the purpose is to achieve relief from acute pain [8].

Rabbi Eliezer Yehuda Waldenberg was asked a question by Rabbi Professor Avraham Steinberg about an incurable patient who was in a great deal of pain. Rabbi Steinberg asked if it would be permitted to raise the level of pain relief medicine, such as morphine, even if it did not treat the underlying disease and could, in fact, hasten death. Rabbi Waldenberg replied that as long as the medicine was prescribed by the physician for the purpose of relieving pain, it is permitted even if the medicine hastens the patient's death. By administering a higher dose of morphine, the physician is reducing pain [8].

The final aspect of medical marijuana that will be discussed here has to do with compassion. Richard Greenberg, a freelance writer in Washington, D.C., discusses compassion as one of the first of *Hashem's* thirteen attributes mentioned in the Torah. We recite these attributes three times on Rosh Hashanah and Yom Kippur. Since Jews are commanded to behave in the image of G-d, we are, by extension, commanded to act with compassion [9]. If a physician is able to relieve a patient from his pain and suffering, and the treatment is *halachically* acceptable, there is a good argument to allow the prescription of medical marijuana [1].

Based on the literature, it seems that physicians may prescribe medical marijuana according to Jewish law. In fact, addictive narcotics are regularly prescribed for the purpose of relieving pain, a practice mandated by *halacha*. However, one still must take into

consideration the conflicting values of pain relief and the potential threats marijuana can pose to a patient's health. Rabbi Shlomo Zalman Auerbach ruled that even on Shabbat, one must relieve a person of his pain, even if just for a limited time. There are

numerous *halachic* aspects of medical marijuana, which must be taken into account when analyzing its permissibility in Jewish law. What remains clear, is that both sides of its use must be looked at- its pain relief capabilities *and* its potential threats. ■

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THE DAVIDIC HARP: AN AEOLIAN AWAKENING

Nicole C. Moskowitz

The existence of musical instruments throughout *Tanakh* is quite remarkable. Be it in the context of mourning, celebration, or ritual, the use of advanced forms of mechanics is quite striking. A most renowned example is the harp (*kinor*) of King David, which, central to the musicality of *Tehillim* and to the book of *Shmuel I*, is oft employed as a cure for King *Shaul's* evil spirit and as a means of giving praise to G-d [1, 2]. While the music of this instrument most commonly results from the plucking of its strings, there exists evidence of an additional, rather unique performance of this harp, one by the powerful northern wind.

The topic of this property of David's harp comes from the Talmud in *Berakhot* which discusses a statement of *Moshe's* from the book of *Shemot*: "About midnight I will go out into the midst of Egypt." The Talmud contrasts *Moshe's* statement with a statement of David's in which David says that at exactly midnight he rises to give thanks to G-d [3, 4, 5]. If *Moshe* did not know the exact time of midnight, as suggested by the term "about," how did King David? The answer, in the name of *Rav Shimon Chasida*, is that David had a device to awaken him: a harp hanging above his bed which would be played when the northern wind of midnight would blow upon it.

The fact that King David had his own alarm clock is incredible. In fact, regarding the above statement from *Shemot*, the *Ibn Ezra* comments: "It is known that a scientist can calculate the moment of midday with great effort and huge copper instruments, but calculating the middle of the night is far more difficult" [6]. In that case, what exactly was the mechanism of this harp; what properties did it hold enabling David to awaken at precisely midnight when it was met by the force of the northern wind?

In essence, David was awakened by an Aeolian harp which, by definition, is played by the wind [7]. In such a phenomenon, the energy of wind is transformed into harmonious sound by the laws of fluid dynamics. A harp most commonly sounds when its strings are plucked and begin to vibrate, causing the air around them to move and creating a sound which is amplified by the soundboard, a component of the instrument which improves the coupling of the vibrating string with the air [8, 9]. However, when

it is the wind that plays the harp another concept – that of vortex-induced vibrations – is featured, which allows the wind energy to be converted into musical tones [10].

What exactly was the mechanism of this harp; what properties did it hold enabling David to awaken at precisely midnight when it was met by the force of the northern wind?

The idea of vortex-induced vibrations is inherent to any situation of fluid flow in which a constant fluid stream encounters a bluff body causing it to change course and produce a very phenomenal pattern in its wake. In the case of the harp, as the wind passes at a high velocity perpendicular to the thin cylindrical strings, vortices form on either side of the string, then close in behind the string in an alternating, counter-rotating fashion, leaving behind what is known as a von Kármán vortex trail [11]. As these alternating vortices break away from the strings with a certain frequency, they slightly lift the strings, causing them to oscillate from side to side at the same frequency [12]. When the frequency of these oscillations matches any harmonic of the string (any integer multiple of the natural frequency which is heard when the strings are plucked), resonance takes place, producing an audible tone which is then amplified by the harp's soundboard [13, 14].

The frequency of these Aeolian vibrations has been studied rigorously, initially by Vincenc Strouhal in 1878, and was discovered to be proportional to the wind's velocity divided by the string's diameter (with a proportionality constant of approximately 0.2 for most velocities) [15]. From this relationship, it becomes obvious that at higher wind velocities, vortices will form more frequently, while at larger string diameters, vortices will form less frequently [16]. For very low wind velocities, in fact, air will simply flow in streamlines over the harp's strings, never forming vortices, and thus not causing the strings to vibrate.

For the case of David's harp, the wind prompting these Aeol-

lian vibrations was the northern wind. As explained by *Rashi*, four winds blow each day, with the northern wind blowing at midnight [17]. Elsewhere, the Talmud states that four winds blow each day and the northern wind blows with all of them [18]. In both cases, the velocity of the northern wind became noticeably increased at precisely midnight, and thus produced an air flow capable of shedding vortices about the harp's strings at a precise frequency to elicit a melodic sound.

In studying these unique mechanics of David's harp, it is important to have a feel for the general design and the material composition and to visualize the instrument which was played by the northern wind. While the precise design of the harp is not known, there exists strong evidence for its form in the coins minted by *Bar Kochba* during his revolt against the Romans. David's harp is among the various emotional objects which were featured on these coins to prompt the Jewish people to attack the Romans [19]. *Bar Kochba* coins feature David's *kinor* with a floating bridge, a soundboard, strings, and tuning pegs, much like the images of Biblical harps seen today [20]. Evidence of the material used to make the harp strings stems from the Talmud, which discusses the ram, an animal which contributes parts of its anatomy to various musical instruments. The ram's intestines, in particular, are commonly used for the strings on a harp [21]. Further, the number of strings on David's harp is also known and stems from *Rabbi Yehudab's* understanding of the phrase in *Tehillim*, "in thy

presence is fullness (soba) of joy" [22]. Rather than "fullness," the word "*soba*" can be interpreted as "seven," from the word of the same root, "*sheva*," because the Davidic harp and that of the *Beit HaMikdash* had seven strings [23]. Together, these details paint an effective picture of the mechanism which allowed David to awaken, faithfully, at midnight.

Finally, returning to the original question in the Talmud – why could *Moshe* not have such a device to pinpoint the precise moment of midnight? The answer lies not in the mechanism of the harp but in the wind that played it. *Yonatan ben Uzziel* explains that when the Jews were about to leave Egypt, the *Ananei HaKavod* lifted them to the place where the *Beit HaMikdash* would be in order for them to offer the *Korban Pesakh*. If the northern wind had blown on this night (and throughout the forty years in the desert) the clouds of glory would have scattered [24]! Therefore, G-d prevented the northern wind from blowing, making David's harp inapplicable as an alarm clock for *Moshe*.

As a mechanism, David's harp of the tenth century BC was undoubtedly sophisticated. The application of vortex-induced vibrations to harness the force of midnight's northern wind is incredible. Moreover, the fact that David utilized fluid dynamics to ensure that he would awaken to praise G-d at precisely midnight is very fascinating and a lesson in the importance of taking advantage of the laws of nature to go beyond the letter of the law in our service of G-d. ■

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SHORT AND SWEET? NOT NECESSARILY

Dahlia Pasik

Human dwarfism is an autosomal recessive disorder caused by the expression of a gene located on the long arm of chromosome 2. The disorder is medically referred to as microcephalic osteodysplastic primordial dwarfism and is phenotypically characterized by a visibly short stature, disproportionate body growth, a sloping forehead, prominent eyes, and small ears. Occasionally, mental retardation is also associated with the disorder. Various hair and skin abnormalities and a marked, steep base at the skull are other common features [1].

Due to the unfavorable consequences of this disorder, the *Gemara* felt the need to draw our attention to it. *Bechorot* 45b states that the opposite of a giant is the *nannas*, which means “dwarf.” According to the commentaries of *Ibn Ezra* and *Targum Yonatan* in *Leviticus* 21:20, the Biblical term, “*dak*,” refers to a dwarf. The *Gemara* also stipulates certain laws and offers some advice with regard to dwarfs. Neither the giant nor the dwarf is permitted to serve as a priest. This is due to the fact that a defect in height was considered to be a blemish, and such a person was therefore unfit to serve in the Temple. Additionally, an abnormally tall man is advised not to marry an equally tall woman, “lest their offspring be like a mast.” Comparatively, a male dwarf should not marry a female dwarf, “lest their offspring be a thimble” [2].

There are several notable dwarfs in *Tanach* including Pharaoh and *Nebuchadnezzar*. In *Daniel* 4:14, the dwarf-like stature of Pharaoh is described. *Avituv*, the scribe, said in the name of *Rav*: “The Pharaoh of Moses’ days was one *amah* tall. His beard was one *amah* long, and his male organ was an *amah* and a *zeres*.” Rabbi Yitzchak Alerstein attested that this description of Pharaoh’s stature does not reflect what Pharaoh actually looked like. Rather, when the Torah describes a person in a way that is beyond realistic biological constraints, it refers to the essence of the person. In other words, the person would, in fact, have the abnormal appearance described if not for the physical limitations of the common body image. This unrealistic and undesirable image describes the hidden Pharaoh, whose nonphysical traits may be invisible to an onlooker. Alternatively, although Pharaoh was not actually “one *amah* tall,” he was, nonetheless, very short and considered a bio-

logical dwarf according to *Chazal* [3].

There are several instances in *Tanach* where *Nebuchadnezzar* is also clearly identified as a dwarf. In *Daniel* 1:14, *Hashem* states that *Nebuchadnezzar* was the smallest person ever to be appointed as a ruler over a kingdom. The *Midrash* in *Yalkut* reaffirms that *Nebuchadnezzar* was, in fact, a dwarf. Additionally, the *Tanna D’Bei Eliyahu Rabbah* (31) states that when *Nebuchadnezzar* went from province to province, the populace would mock him for his short stature saying, “Does this one rule from one end of the earth to the other?” People were shocked by the incongruity between *Nebuchadnezzar*’s great power and his short physical stature. Ad-

There are several notable dwarfs in Tanach including Pharaoh and Nebuchadnezzar.

ditionally, on three separate occasions, G-d complained of the wicked *Nebuchadnezzar*, “See what this dwarf from Babylon has done to Me!” (*Pesikta d’Rav Kahana* 13:42).

Dwarfism can have an interesting psychological impact on the affected individual’s personality. Studies have shown that very short people sometimes develop a “Napoleon complex,” characterized by the drive to gain power and control others [4]. This “short-man syndrome” usually develops at an early age and is the result of constant ridicule and bullying by peers. Short people tend to be less materially successful than taller people and, therefore, feel the need to exert their control [5].

The psychological need of short people to appear as powerful individuals is especially seen in the egotistic complexes of Pharaoh and *Nebuchadnezzar*. *Tanchuma Vayeira* states that there were four people who deemed themselves as god-like: Pharaoh, *Nebuchadnezzar*, Hiram, and Joash. *Shemos Rabbah* explains that Pharaoh was willing to endure pain in order not to defecate during the day. Pharaoh believed he could trick the Egyptians into thinking that he was a powerful Egyptian god. In *Megilla* (11a), *Nebuchadnezzar* is described as a “haughty” and “short” tyrant. Interestingly, in *Devarim Rabbah* (1:5), the haughty *Nebuchadnezzar* is quoted as

having said, “All the inhabitants of the earth are reckoned for nothing.”

It is apparent through analysis of *Tanach* that Pharaoh and *Nebuchadnezzar* presented with dwarfism, a physical pathology that may have contributed to their evil personas. Pharaoh, the nefarious ruler that enslaved the Jewish nation, was obsessed with having a god-like appearance, and only relieved himself at night as stated in many complementary sources of *Sbemos*. Comparatively,

Nebuchadnezzar, the evil tyrant that initiated the first exile upon his destruction of the First Temple, was known for his marked egoism, as he ruled from “one end of the earth to the other.” We may conclude that these powerful dwarfs exerted excessive control to compensate for the insecurities they felt about their physical make-up. As such, it is likely that the psychological phenomenon of the “Napoleon Complex” contributed to the great plight of the Jewish nation during countless marked periods in history. ■

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DAVID VERSUS GOLIATH: A ROCKY TALE

Kate Rosenblatt

The famous Biblical story of David and Goliath is a mind-blowing tale of a young Israelite shepherd boy who uses his tremendous faith in G-d and a simple sling to single-handedly defeat a Philistine giant [1]. Several scholars feel that the idea of a robustly armored giant conquered by a mere youth armed with only a sling is too difficult to accept. As such, some modern hypotheses have suggested that Goliath suffered from various medical conditions, effectively weakening the giant during his encounter with David [2]. However, most Biblical commentators and scholars do not diagnose Goliath with any medical ailments. In fact, *Rav* (as in *Rav* and *Shmuel* from the Talmud) explains that Goliath was physically perfect [3]. This description would unlikely be associated with a diseased person. Viewing the *pesukim* from a different angle, in fact, makes it completely unnecessary to assume that Goliath's health was compromised at the time of the battle [4]. We may reasonably conclude that despite Goliath's physical fitness and impressive weapons, David cleverly employed the natural laws of physics to defeat the giant.

Before delving into the physics of David and Goliath's battle, it is worthwhile to discuss some important background information to the story. Goliath is first introduced as a Philistine giant and "champion" of war. On behalf of the entire Philistine camp, Goliath arrogantly approaches the Israelites and offers a solution to the standoff between the two armies. However, it is a solution which clearly lies in favor of the Philistines considering Goliath's enormous size and strength. If Goliath is triumphant in battle, then all the Israelites must become servants to the Philistines. However, if an Israelite emerges as the victor, then the consequences are reversed in favor of the Israelites. Essentially, only one life would need to be taken in battle in order to determine the triumphant army [5].

Over the following forty days, Goliath approaches the Israelite army twice a day, once in the morning and once in the evening. The Israelites become more fearful, and Goliath becomes more arrogant as his daily offer to fight any Israelite is gradually transformed from a challenge to a taunt with each passing day [5]. Certainly, Goliath's challenge is easy to make because of his

enormous size and strength. With regard to his height, the *pasuk* says that Goliath was "six cubits and a span." According to *Rav Dovid Qimchi*, a cubit is approximately two feet, and a span is half of a cubit. This means that Goliath was about 13 feet tall [2]. Other sources give Goliath a height of approximately ten feet [6]. Either way, if Goliath were a basketball player today, he could

Although the sling is considered a low-status weapon, it can be very deadly in the hands of an expert.

easily "slam-dunk" a basketball with his feet flat on the ground [5]. Furthermore, a man of that height could easily weigh close to 500, or even 600 pounds. If Goliath's height was not intimidating enough, then his suit of armor would certainly do the trick. *Pesukim* 6 and 7 describe that Goliath was donned from head to toe in metal armor weighing "5,000 copper shekels." The blade of his spear alone weighed "600 iron shekels" [1]. Converting shekels to pounds, Goliath's armor weighed about 125 pounds and his spearhead 15 pounds [6]. It is very understandable from this viewpoint why the Israelites feared him so much. It would certainly take an extraordinarily courageous soldier to defeat him.

Ironically, Goliath's eventual opponent, David, is not a soldier at all. And when we are introduced to him nothing is described regarding his strength, size, or weapons. It was David's faith and strength of character, and not his appearance, which would make him qualified for the task of bringing down Goliath. David's three oldest brothers have gone out to war with King Saul while David remains at home to care for his father's sheep. However, David emerges on the scene when his aged father, too weak to travel to the army camp himself, instructs David to go to the Israelite camp where he is to bring supplies to his brothers. At the camp, David finds his brothers. As he is speaking to them, he hears Goliath's challenge and his cursing of the Israelites and G-d. As David observes his fellow Israelites cringe in fear of this giant, he hears from the soldiers that King Saul has offered some very generous prizes to whomever volunteers to take down Go-

liath. Apparently, King Saul has promised not only a substantial amount of wealth, but also his daughter's hand in marriage and exemption from taxes for the volunteer's family [5].

David then asks several people around him to confirm what he has just heard. Wouldn't any true soldier of King Saul take advantage of this tremendous privilege to defeat Goliath? After all, this giant is cursing G-d and David has full faith that G-d will give the victory to whomever steps up to the plate. On top of that, the king is offering all these fabulous gifts! Utterly perplexed, David keeps asking around to ensure that what he has heard about King Saul's offer is correct. Why is no one accepting this honorable challenge [5]?

Angered by the sight of his younger brother's inquiries, Eliab, David's oldest brother, ruthlessly cuts into David. "Why have you come down? And with whom have you left those few sheep in the wilderness? I know the wickedness of your heart; for you have come down to see the battle" (1 Samuel 17:28). Actually, in every area where Eliab accuses David of doing something wrong, David's actions were completely innocent and even praiseworthy. David's appearance on the battlefield was prompted by his father's instructions to travel there, and not by childish curiosity as Eliab had accused. David also responsibly appointed a supervisor over the sheep while he would be away. Despite Eliab's insulting and discouraging remarks, David is not deterred by them, and continues asking around to ensure that what he has heard about King Saul's great offer is, in fact, correct [5].

When Saul hears about David's inquiries he summons him to his quarters, where David expresses to King Saul his wish to fight Goliath. Upon noticing David's youthful countenance, King Saul replies that David is too young and, therefore, not experienced enough to defeat Goliath who has been a warrior since his youth. However, David explains that he had killed simultaneously a lion and a bear with his bare hands in a courageous and successful attempt to rescue one of his father's sheep [1]. According to the *Malbim*, David reasoned with King Saul that Goliath's strength would at most be equivalent to the strength of only one of these wild beasts [7]. David proves to King Saul his warrior abilities so convincingly that the king allows David to fight Goliath on behalf of the entire Jewish people. It seems that David's "trivial" duty of caring for his father's flock of sheep has prepared him quite nicely for his upcoming battle with Goliath [5].

Determined and fearless, David goes to a nearby brook to pick up his fatal weapons - five smooth stones. He places the stones in his pouch and heads toward the battlefield, a stick in one hand and a sling in the other. Goliath must have been completely beside himself at the sight of David. Here we have a 13-foot tall

giant, adorned in metal armor from head to toe, confronted by an unarmored youth carrying a stick and, at this point in time, an empty sling. The onlookers must have been overcome with great trepidation and utter confusion. Goliath's likely surprise at the sight of his apparently unprepared enemy quickly turned to disdain as he curses David by his gods and roars that he will deliver David's flesh "to the birds of the sky and the beasts of the field!" David then boldly asserts what is probably one of the most famous Biblical quotes: "You come to me with a sword, a spear, and a javelin, but I come to you in the name of G-d." Goliath had no idea that his physical weapons would pale in the face of David's spiritual ammunition. The battle rapidly ensued and ended as David quickly ran toward the battle line to the Philistine, pulled a stone out of his pouch, slung it, and fatally struck the Philistine in the forehead [1].

Clearly, Goliath should not have underestimated the lethal power of the sling. Although the sling is considered a low-status weapon, it can be very deadly in the hands of an expert. Since the sling requires few resources and is easily produced, it was the preferred weapon among shepherds in the field due to its effectiveness in warding off threatening animals [8]. As such, David, inexperienced with traditional armor and weapons, selected the sling with which he was familiar [4]. In fact, the sling was a commonly used weapon among the Israelite militia [8]. For example, in the Book of Judges it is noted that during war "everyone could sling stones at a hair breadth, and not miss" [9]. The common use of the sling in the Israelite army was due to the sling's effectiveness and ease of production. It is unclear exactly when men first started slinging stones instead of throwing them, but clearly, men learned at some point that stones could be slung with greater speed, range, and accuracy than they could be thrown with bare hands [8].

Stones from riverbeds, as the ones that David took with him to battle, were the most popular due to their polished smoothness. Smooth stones were preferable over edged rocks because they experienced reduced effects of air resistance, enabling greater accuracy and range [10]. In addition to the fact that the stones were smooth, *Rasbi* comments that the stones were also thin [11]. The force of air resistance would be weaker against thin stones as opposed to wider ones [10].

According to literature on weapon history, slung stones could reach speeds up to 90 meters per second. The sling could also achieve an average range of 150 to 500 meters depending on the weight of the stone and the length of the sling. Longer slings could achieve a longer range [10]. Currently, Larry Bray holds the Guinness World Record for slinging a stone projectile (52 grams)

437.1 meters [8]. That's approximately four times the length of a football field. Arguably, ancient slingers who trained since childhood and relied on the sling for survival in battle could approach an even greater range, close to 600 meters [10].

A sling could be made by anyone as its construction did not require any level of real skill as with other weapons such as the bow. Various materials could be used to make the cords and pouch of the sling. Non-elastic materials such as sinew, plant fibers, animal hide, and hair were among the more common resources. At the center of the sling, a cradle is constructed for the placement of the stone. When in use the cradle folds around the projectile. At the end of one cord of the sling, a finger-loop is formed, which is placed over the second finger. At the end of the other cord, it is typical to tie a knot. The knot is held between the index finger and the thumb to be released at the right moment [8].

Even if the stone did not penetrate the armor, it was capable of crushing bones and inflicting a fatal internal injury.

There are several different slinging methods, but the overhand and underhand techniques are the two basic divisions of throwing. In an overhand throw, the sling is swung in a counter-clockwise motion and the projectile is released at the top of the arc from where it travels parallel to the surface of the earth toward the target. In an underhand throw, the sling is swung in a clockwise motion and the projectile is released at the bottom of the arc. In both slinging techniques, the slinger should perform various body motions in the direction of the target in order to add as much speed to the sling missile as possible. Range is believed to be increased with the underhand method, but it is more difficult to master in terms of accuracy. However, some archaeologists feel that once mastered, the underhand motion was the optimal way to use the sling. Another slinging method is to whirl the sling in a circular motion over the head. Regardless of which method is used, a skillful throw may require just one rapid rotation of the sling [8].

We do not know which sling technique David used. However, regardless of the method that he utilized we may assume that after loading the stone in its cradle, David began to whirl the sling in a circular orbit. While the sling was subjected to a circular motion, the stone exerted a force on the cradle, tightening the cords of the sling. The basic physical principle that played a role here is

that a force is necessary for maintaining the motion of an object to a circular path [12].

Another important point is that while centripetal acceleration (that is, acceleration toward the center) guarantees circular motion, tangential acceleration increases the magnitude of the tangential velocity. As such, the tangential velocity went from zero meters per second to a very large value as David whirled the sling [13].

David probably made no more than one or two rapid rotations of the sling, and with Divine timing, released one of the sling's cords to set the projectile into its fantastic motion. The stone embarked on a parabolic trajectory toward Goliath's forehead. With only the slight force of the Earth's gravity and negligible air resistance to compete with, the stone struck Goliath with deadly force. Here we have another important physical principle that came into play. The moment that the constraining force is removed, the object will move along a tangent of the circular orbit. Highly skilled with the sling, David released the projectile on a perfect path toward his target [12, 13].

It is curious what force the stone had when it penetrated Goliath's skull. The force must have been quite strong, but considering that accurate data and measurements cannot be acquired, only very rough approximations will be used to estimate it. The tangential velocity of the stone in its circular orbit may be calculated by taking $2\pi r/T$, where r is the radius of the circular path, and T , the period, is the time it takes to complete one rotation [14]. However, this formula is not very useful here for several reasons. The slinger engages in all sorts of body motions to increase the speed of the stone just before releasing it from the sling [8]. One of the most important body motions is probably the extremely quick flick of the wrist which the slinger performs just as he is releasing the stone. This quick flick of the wrist increases the velocity of the stone exponentially. Furthermore, the *pasuk* informs us that as David approached the battle line with sling in hand, he ran, increasing the velocity of the stone even more [6].

It has been shown that a stone can be released from a sling with a speed that is much greater than the speed of a baseball thrown by a professional baseball pitcher - approximately 100 miles per hour [6]. This translates to a velocity of 45 meters per second. According to the literature, slung stones could reach velocities of 90 meters per second [10]. We can assume this literature value for the velocity of the stone that David slung; consider David the champion baseball pitcher of the Jewish leagues. We may also assume that the velocity of the stone remained constant in the horizontal direction assuming negligible air resistance and a relatively short distance between the two warriors. The gravitational force only changes the vertical velocity accelerating the

projectile down. However, it will be assumed that most of the stone's velocity was confined to the horizontal path of the projectile. To get the force that the stone exerted on Goliath's forehead, we take the momentum of the stone and divide it by the time taken to penetrate the giant's forehead starting from the moment that the stone made contact with his flesh. Momentum is defined as the product of the object's mass and velocity [13]. The mass of a typical stone used for slinging was about 50 grams (5×10^{-2} kilograms) [8]. However, stones with mass of up to 500 grams were often used as well [8]. The product of the stone's mass (assumed 5×10^{-2} kilograms) and velocity is therefore equivalent to 4.5 kilogram meters per second. Having in mind that the velocity of the stone was approximately 90 meters per second, some simple calculations show that it would have probably taken less than 1 millisecond to penetrate one inch through Goliath's forehead. However, since the stone's velocity rapidly decreased as it penetrated the giant's forehead, a penetration time of 3 milliseconds will be assumed. The force of the stone would then have been approximately 1500 Newtons [13]. This force is approximately one-sixteenth the force of a typical handgun bullet through a human skull (which is 25,000 Newtons assuming a bullet speed of 300 meters per second and a penetration time of slightly more than half of one millisecond) [15]. This is an enormous force, and it was applied in an instant over a small area. Similarly to a karate expert's performance in breaking slabs of concrete, a large amount of force applied over a short time in a small area will result in maximal damage [6].

It may be more useful to solve for the pressure that was exerted by the stone on the giant's forehead. Pressure is defined as force per unit area. Having already solved for the force, the area remains to be calculated. The surface area of a circular object is πr^2 , where r is the radius of the circle. Ancient stone projectiles were approximately 43 millimeters in diameter (0.043 meters), comparable to a golf ball. Assuming this diameter, the radius was 0.0215 meters. Substituting this value into the formula for surface area of a circle, we get 0.00145 meters². Dividing the force, 1500 Newtons, by this value gives the pressure that the stone exerted on the giant's forehead - approximately 1.0×10^6 Newtons per meter² [13]. Such an enormous pressure would certainly have been enough to puncture the giant's forehead even though his skull was probably thicker than an average human's. According to one source, a pressure of 2.5×10^5 Newtons per meter² (36 pounds per square inch) is sufficient to crush a human skull [16].

Now that we have established that the stone had sufficient force and pressure to penetrate Goliath's forehead, we are still left with a puzzling question. The *Navi* relays that Goliath was

covered from head to toe in metal armor. Considering Goliath's apparent conscientiousness in covering his entire body with armor, it is almost unreasonable to suspect that he would have entered battle without protective gear on the most delicate part of his body – his head. Many depictions of ancient battle scenes show that helmets were designed to cover the top and sides of the head, but not the forehead. This would have effectively exposed Goliath's forehead to the stone. However, the *Radak* assumes that Goliath must have been wearing a helmet with a shielding area over the forehead. According to several explanations offered by the *Radak*, something clearly went wrong (or rather right) despite the helmet's completely protective design. The *Radak* first tries to reconcile the problem by pointing to an event that immediately preceded David's slinging of the stone. Goliath roared that he would deliver David's flesh to the birds of the sky. In doing so, he looked up and pointed skyward. As a result, the part of his helmet that protects the forehead slid back and rested on top of his helmet, exposing his forehead to the deadly stone. The *Radak* also suggests that perhaps there was a small exposed space in Goliath's helmet that was still large enough to allow the stone to pass through. David may have slung the stone with such perfect accuracy that it entered this small exposed space in Goliath's helmet. Another explanation suggested by the *Radak* is that the stone penetrated both the metal helmet and Goliath's forehead [17]. Strictly using the natural laws of physics, this method of penetration into Goliath's forehead is unlikely. However, it should be noted that this explanation is based on *Midrash*, which does not always serve to be taken literally.

Still, the impact of a slung stone should not be underestimated even in the presence of shielding armor. Vegetius, a Roman writer in the 4th century, once observed that "soldiers, despite their defensive armor, are often more aggravated by the round stones from the sling than by all the arrows of the enemy" [10]. Even if the stone did not penetrate the armor, it was capable of crushing bones and inflicting a fatal internal injury. Certainly, unarmored bodies were easily penetrated by sling missiles. In fact, an ancient medical textbook, discovered in an archaeological dig, included instructions for removing sling missiles from wounded soldiers [18]. Further demonstrating the power of the sling, an observer recorded during the Spanish conquest of the Aztec empire in the 15th century that an Andean slinger could shatter Spanish swords or kill a horse in one hit! In fact, almost until modern times, slings could be used quite successfully against Spanish firearms from a distance of 50 yards. The last recorded martial use of the sling was during the Spanish Civil War in 1936, which is very recent considering the ancient origins of this weapon. Although its use

requires tremendous skill, the sling's power, range, and accuracy enabled its effectiveness as a deadly weapon of war even up until relatively recent times [10].

It should then remain little wonder why David chose the sling as his weapon against Goliath. With knowledge of the sling's advantages and a skillful technique, David must have figured it was the optimal weapon of choice. Since the stone, in fact, penetrated Goliath's forehead, David was obviously correct in his judgment. While all the onlookers were probably in shock after observing David's spectacular feat, the immediate aftermath of the stone's contact with Goliath's forehead seems to be almost equally puzzling to some Biblical commentators. With the stone having enough force to penetrate Goliath's forehead, one might predict that the impact would have sent the giant falling backward. Yet, the *pasuk* informs us that Goliath fell forward. Troubled by this apparent contradiction, *Rashi* explains that G-d deliberately orchestrated this peculiar occurrence in order to reduce David's burden when he would eventually run over to the unconscious giant to cut off his head. Had Goliath fallen backward, David would have had to walk an additional distance of twice Goliath's height in order to reach the giant - one time his height for not falling forward and one time his height for falling backward [19]. This explanation may suggest that *Rashi* did not believe that natural laws could explain why Goliath fell forward. As such, an explanation involving G-d's obvious intervention was required. The *Malbim* on the other hand implies that this part of the story does not require an explanation involving an obvious miracle. The *Malbim* seems to believe that while the force of the stone was strong enough to puncture Goliath's forehead it did not necessitate a backward fall. Goliath's fall was less a result of the stone's momentum than the giant's physical weakness, an immediate result of the stone's impact [20]. In support of the *Malbim's* view, it is currently understood that gunshot victims frequently collapse, when shot, due to physical damage or weakness and psychological effects rather than the momentum of the bullet [21]. It is also possible that even after

the stone sank into the giant's forehead, Goliath still had some forward momentum carrying his body forward until collapsing to the ground moments later [6].

It is worth noting that the stone's force did not need to be strong enough to actually kill Goliath. It only needed to be strong enough to knock him unconscious. According to the *Malbim* Goliath still had "*ruach chaim bo*," "the spirit of life in him," even after the stone penetrated his forehead. The giant did not actually die until David cut off his head [22]. From this point of view, the role of *derech hateva* in Goliath's demise is even more convincing.

While David certainly could have defeated a 13-foot tall giant using the physical laws that govern our world, the suggestion in no way undermines G-d's presence at this battle. G-d's Providence can certainly operate through the natural laws of the world. In fact, several Biblical commentators, including the *Malbim*, approach Biblical text with this outlook. According to the *Malbim*, the fact that David struck the giant at all, let alone on his first try, demonstrates G-d's profound presence during David and Goliath's encounter [20]. Had David used all five stones that he carried, and struck Goliath only with the fifth stone, the feat still would have been tremendously impressive.

Another important point is that many people probably think that the only miracle of this story is David's defeat of Goliath. However, we cannot forget all the obstacles that David had to deal with even before he confronted the giant. First, David was not even part of King Saul's army. He was left to supervise his father's sheep several miles away from the battlefield. David also had to get past his oldest brother, Eliab, who made some very discouraging remarks toward David to say the least. Finally, David needed King Saul's official approval to fight Goliath [1, 5]. Clearly, Divine intervention was required in order to orchestrate the events just leading up to David's presence on the battlefield. "A man after G-d's own heart" (1 Samuel 16:7), David then courageously employed the laws of physics to carry out G-d's will and bring salvation to the Jewish people. ■

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SALT AND PEPPER: SIGNIFICANT MEDICAL AND BIBLICAL CONTRIBUTIONS

Samantha Selesny

Like many middle-aged men, my father has hair that is turning gray. Some time ago, people decided to give that look a name: salt and pepper. Salt and pepper, however, is not just a more distinguished reference for “turning older and grayer.” Its reference to someone who has experienced much of life brings a connotation of stability, of something that is comforting and enduring. The real salt and pepper, from which the hair color gets its name, is just as enduring. They have been paired together on tables for years, but their historical significance is rarely considered. The medical and biblical effects of these dinner condiments are numerous and have had great impact on society.

Salt

Salt makes its debut in the Bible at the very beginning of Genesis (1:6). On the second day of creation G-d created a firmament between the upper and lower waters to separate them. Distressed over the physical distance between themselves and G-d, the lower waters complained that they, too, wanted to be like the upper waters that were privileged to remain with Him in heaven and that they did not want to remain on earth with mere mortals. To rectify the situation, G-d promised the salty waters of the ocean that in the future, salt would eventually be an integral component of the sacrifices brought in the Holy Temple, as it is written in Leviticus (2:13), “You may not discontinue the salt of your G-d’s covenant from upon your meal-offering - on your every offering shall you offer salt” (*Bereishis Rabbah* 5:4).

With the Temple no longer standing, we still try to maintain this covenant today through symbolic actions. When eating religious meals, a blessing is recited on two loaves of bread that rest on a tabletop, which represents an altar. The loaves are accompanied by salt to symbolize the sacrificial worship that took place in the Temple. Furthermore, salt strengthens a person’s health so that he may serve his Creator more vigorously (*Shulchan Aruch Orach Chayim* 167:5).

Salt becomes significant once again prior to the blessing that we recite after meals, commonly known as *Birkat Hamazon* (*Erwin* 17b). The Rabbis deemed it obligatory to wash one’s hands before this blessing, not for symbolic reasons, but rather for medical pur-

poses. They considered a certain Sodomitic salt that causes blindness if exposed to the eyes. This blindness occurs because of the osmotic properties of salt. Osmosis is the movement of water molecules through a selectively permeable membrane into an area of higher concentration of solute. This is in order to preserve an equal balance of solute concentrations on both sides of the membrane [1]. When a highly concentrated salt solution (in this case, Sodomitic salt) is placed upon living tissues of the eye, water flows out from the ocular cells to maintain solute equilibrium. A significant amount of water is lost from the cells causing permanent damage to the eye (Tosefet Chulin 105a) [2].

Although the osmotic property of salt is a fascinating process, perhaps the most incredible Biblical reference to salt is the transformation of Lot’s wife into this substance.

The osmotic property of salt also manifests itself in another part of Judaism: koshering meat. The Bible explicitly prohibits any consumption of blood: “Any person who consumes blood will have his soul cut off from its people” (*Leviticus* 7:27). To remove blood from newly slaughtered meat, a *shochet* (ritual slaughterer) uses the osmotic property of salt to create a hypertonic, or relatively highly concentrated, salt solution. When applied, the blood is drawn from the meat. Because of the large quantities of blood present in the animal, a *shochet* needs to salt heavily, using larger grains of salt than those of common table salt. This heavier, more capable salt that is used is now called “kosher salt” because of this particular use. Although it is crystallized into larger particles when processed, kosher salt is chemically identical to all other pure forms of salt [3].

Although the osmotic property of salt is a fascinating process, perhaps the most incredible Biblical reference to salt is the transformation of Lot’s wife into this substance. When G-d destroyed

the evil-ridden city of Sodom, raining upon it “sulfur and fire” (*Genesis* 19:24), He mercifully allowed Lot and his family to escape this terrible fate on the condition that they not turn back and view the destruction of their fellow man. Disobeying G-d’s command, Lot’s wife turned around to view the demise of the city’s inhabitants and as a punishment, was immediately transformed into a pillar of salt (*Genesis* 19:15-26). Scientifically speaking, a rapid change in the homeostasis of Mrs. Lot must have occurred for this chemical mystery to take place. To explain this phenomenon from a chemical perspective, we must recognize that the term ‘salt’ used here may not be referring to sodium chloride (NaCl), which we have been discussing until now. Rather, Lot’s wife may have turned into a different salt, calcite (CaCO_3), which is unlikely to be found on our tables.

Solid calcite is formed through a very favorable relation between aqueous calcium cations, Ca^{+2} , and carbonate anions, CO_3^{-2} . It should be noted that the solubility product of $[\text{Ca}^{+2}][\text{CO}_3^{-2}]$ is 4.57×10^{-9} , where brackets represent concentrations of the respective species. This value indicates the very low solubility of calcite, which further decreases when the temperature is increased. CO_3^{-2} is also important in regulating blood pH. In order to maintain proper blood pH, the concentrations of CO_2 , CO_3^{-2} , HCO_3^- , and H_2CO_3 , must be maintained, as shown in the equilibrium:



Heightened levels of CO_2 force the equilibrium backwards (to the left), which raises blood pH. To connect the concentration of calcium with the concentration of CO_2 , we use the equation: $[\text{Ca}^{+2}][\text{PCO}_2]/[\text{CO}_3^{-2}] = 1.55 \times 10^{-5}$, which combines the carbon dioxide pressure (PCO_2), the free calcium cation concentration, and the precipitous appearance of CaCO_3 . Furthermore, about half of the Ca^{+2} in the human body is bound to plasma albumin. Lowering the pH drastically reduces this interaction, freeing these cations into the blood stream. A high concentration of CO_2 and of free calcium cations, along with an increased temperature, results in a high precipitation of CaCO_3 [5].

With these facts in mind, two events must have occurred with regard to Lot’s wife. Firstly, because of the high temperatures radiating from Sodom, Mrs. Lot’s body temperature must have risen because of her proximity to the fiery destruction. Secondly, she was hit in the face with a large blast of CO_2 when she turned around. The high temperature denatured the albumin to which calcium was formerly bound, and the rise in CO_2 concentration lowered her blood pH, creating elevated concentrations of free calcium cations. This surge of calcium cations coupled with the invasion of CO_2 into her organs, along with the subsequent rise in blood pH, possibly triggered a massive scale formation of solid

calcite throughout her entire body. Lot’s wife was transformed into one large pillar of salt [4].

Pepper

There are several varieties of pepper, but the one used as a condiment is generally black pepper, derived from the vegetable, *Piper nigrum*. This form of pepper is the world’s most widely used spice [5]. Pepper possesses several qualities that can be attributed to one of its chemical components, piperine. Piperine is an alkaloid of pyridiene, which gives pepper many of its specific characteristics. The qualities of black pepper give it not only positive taste-related properties, but contribute to a variety of favorable physiological effects, as well. In recent studies, piperine has been shown to enhance the bioavailability of therapeutic drugs by increasing their plasma half-life and delaying their excretion. Piperine also possesses an antioxidant effect. Oxygen radical injury and lipid peroxidation are suggested as major causes of cancer. Reactive oxygen species generated from chemical carcinogens can cause cell damage and in turn stimulate the process of carcinogenesis. Antioxidants have properties that inhibit this oxidation. Piperine protects against oxidative damage by preventing the formation of reactive oxygen species and lipid peroxidation [6].

Furthermore, piperine has a positive influence on the gastrointestinal system. It improves intestinal motility and it enhances intestinal functioning by increasing the length of the intestinal microvilli. The increased length raises the absorptive ability of the small intestine. This property enhances the efficient permeation of nutrients through the epithelial cell barrier and thereby increases the absorption of nutrients [6].

Talmudic scholars refer numerous times to the benefits of this spice. In Shabbat 90a, pepper is identified as a sweetening condiment, and a mixture of wine, honey, and pepper was a delicacy served to dinner guests. It also functions as a deodorizer of bad breath. Bad breath is listed as one of the imperfections that prevents a *kohen*, or priest, from serving in the Holy Temple. A treatment to remedy this physical shortcoming was to place pepper in his mouth, which enabled him to successfully continue his duties (Shabbat 90a). Pepper is elsewhere identified as beneficial for the entire body, not just the mouth, and to improve overall health (*Pesachim* 42b), as shown in modern day studies.

Rabbis have also deemed it important to discuss the *kashrus* of pepper, which draws attention to its significance in Judaism. Although pepper is naturally kosher because it is a botanical, it is important to note that as a spice, it must be checked that it does not harbor any insects, which would deem it non-kosher. The method of drying spices, as a means of preservation, can also pose interesting *kashrus* issues. Since most spices that are dried in

their original countries are dried in the sun or hot air equipment specifically made for those products, there are little concerns. However, freeze-dried spices pose a special *kashrus* concern. In the process of freeze drying, much of the equipment used is often not specifically reserved for spices and may be used for other non-kosher foods. Therefore it is important that pepper, or any spice, have a reliable *mashgiach*, or supervisor, overseeing the drying process [3].

While salt and pepper may seem mundane when compared with other spices, they have been a part of religion, medicine and history like no others have. They have been staples of both diets and rituals for thousands of years. While other spices are stored away in kitchens and pantries, salt and pepper almost always sit in special shakers in the middle of every table. This place of honor provides just a hint of the importance that salt and pepper have maintained in people's lives and beliefs for generations. ■

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MAN AS GUARDIAN: ENVIRONMENTAL ISSUES IN TANAKH AND TALMUD

Rose Snyder

With the rise of industrialization and modern technology, a movement that strives to counteract some of the negative effects of industrialization has also grown in power and support. Environmentalism, as this social movement has come to be known, is an attempt to preserve the natural environment. As development of technology rapidly increases, so does destruction of natural ecosystems: “Motivated by short-term profit, people have been destroying the world in which they live, destroying rain forests, polluting the water and air, depleting natural resources, and bringing about global warming and the extinction of various species of animals and plants” [1]. Environmentalism is an attempt to strike a balance between human industrial progress and preservation of the natural world. Interestingly, the balance between these two forces which modern man struggles to create is one that can be found throughout Tanakh and Talmud. The issues concerning wastefulness and pollution, which are now deemed environmental concerns, have in fact troubled mankind from time immemorial. These issues discussed in Tanakh and Talmud form the basis of Jewish Environmentalism.

One *halakhic* concern that is discussed in the Talmud and in later Rabbinic literature is the question of air pollution. A large section of *Bava Batra* is dedicated to describing the various regulations for avoiding nuisance, damage, and injury caused by air pollution between neighbors. Air pollution is considered indirect damage, as it must travel some distance before affecting the neighbor, but is still forbidden according to *halakha*. When discussed in the Talmud, air pollution refers to smoke and bad smells, for which “there is no acquisition of rights” (*Bava Batra* 23a). This statement in the Talmud teaches that an individual may not acquire the rights to cause air pollution that negatively affects his neighbors. Some stipulations, however, regarding when this law applies are important. The pollution must be large and frequent, as only under these circumstances is it considered unbearable. Additionally, when the pollution is the source of livelihood for the neighbor, the individual being bothered by the pollution may not demand that the source of the pollution be taken away [2]. Because these details of the circumstances may change and the

situations can become very complex, *halakhic* authorities are continuously consulted in matters of disputes between neighbors.

Regarding the verse, “For is the tree of the field a person” (*Devarim* 20:19), the Netziv comments that man is compared to a tree as a reminder that he is a part of the cycle of nature.

The underlying principles of the laws regarding air pollution that are outlined in *Bava Batra* can be applied to the industrialized world in which we live today. Smoke that comes from large plants can, by definition, be considered large and frequent, and, therefore, unbearable. This categorization gives the neighbor bothered by the smoke the right to have its source removed. However, industrial plants are also economically vital to a large number of people. Often, entire towns depend on the revenue and jobs that an industrial plant provides. Demanding to shut down the plant would cause financial paralysis to many people, in which case there is no *halakhic* backing to demanding the source of the air pollution be removed.

Another consideration to be taken into account when applying these laws to the modern era is the scientific knowledge about air pollution that has been discovered since Talmudic times. While the Talmud discusses the nuisance of air pollution and its damage to personal property, it does not discuss damage to one’s health. Polycyclic aromatic hydrocarbons (PAHs) result from the combustion of organic molecules. They are found in automobile exhaust, factory smoke, and incinerator emission. They are also known mutagens, and in adults, long term exposure to PAHs increases the risk of death due to lung cancer by 8% [3]. A deeper understanding of the dangers of smoke could result in stricter standards regulating air pollution between neighbors. Additionally, the *halakha* only considers the harm that affects the immediate community. The understanding back then of air pollution did not include the possibility that toxins in the air could spread to neighboring villages, especially if the toxins enter the water system.

Increasing industrialization brings with it increasing potential for long-term and long-range damage [4]. With these new possibilities in mind, a new look at the laws governing neighbor disputes over air pollution might be warranted.

The above-mentioned *halakhic* discussions are important in showing that problems now considered environmental concerns have their roots in Jewish tradition. However, the basis of these concerns in the *halakhic* literature is the nuisance and damage that they cause to neighbors; a concern for the natural environment and its preservation does not surface in any of those *halakhic* discussions. The concern for guarding the natural earth does, however, come up in other Biblical and Talmudic sources.

Two main schools of ecological thought that highlight the tension between industrial progress and preservation of nature explore man's place in the world. The anthropocentric approach places man at the center, while the biocentric approach raises nature as the most important element [1]. The anthropocentric approach can be described by a metaphor offered by Bahya Ibn Paquda in his book, *Hovot ha-Levavot* (Duties of the Heart); the earth is compared to a house and man to its owner who "uses all that is in it" [5]. Man, as the center of creation, may use the earth as he sees fit for his own benefit. However, Jewish tradition often places man within nature rather than above it. Regarding the verse, "For is the tree of the field a person" (*Devarim* 20:19), the *Netziv* comments that man is compared to a tree as a reminder that he is a part of the cycle of nature [6]. These two views are highlighted in the Talmud (*Sanhedrin* 38a) as well; the following question is posed: why was man created on the final day of creation? One answer given explains that this was done so that when man entered the world everything would be ready for him to use, emphasizing the anthropocentric approach. Another answer cited, however, explains that man was created last so that if he were to ever become haughty, G-d would say to him, "the mosquito was created before you," emphasizing the biocentric approach [1].

There is yet another story, this time from the *midrash*, which describes the story of creation and gives a new approach to the two ecological schools of thought: When G-d created Adam He took him to see all the trees of the Garden of Eden and said to him, "See how good they are. Everything that I have created, I created for you. Pay attention that you don't destroy My world for if you destroy it, there is no one to fix it afterwards." [6]. The *midrash* seems to imply a synthesis of the two world-views. While G-d created the world for man, placing man at the center, He charged man with a specific mission not to destroy the world. Man can use the earth for his benefit as long as his creativity and constant movement do not damage the earth. While he is the pin-

nacle of creation, he also has limitations. Jewish tradition emphasizes "man's position as guardian, not master, of the earth" [4].

Biblical commandments that contain the theme of protecting the natural environment give man guidelines for acting as guardians of the land. When G-d commands Adam to conquer the land and subdue it (*Breishit* 1:28), He also gives Adam limitations to the subjugation of earth for human progress. In Scripture is written, "When you besiege a city for many days to fight and conquer it, do not destroy its trees, because you eat from them, and do not cut it down" (*Devarim* 20:19). We are prohibited from cutting down fruit trees because this type of behavior is destructive, and the Talmud extends this prohibition to include tearing clothing, destroying buildings, wasting money, fuel, food, or drink, or ruining anything that can benefit people. *Rambam* (Maimonides) explains that these added prohibitions are Rabbinically, not Biblically, proscribed. Nonetheless, we are taught that unnecessary destruction is prohibited. This prohibition, commonly referred to as *bal tasbehit*, is often extended to many areas of environmental concern. For example, the Talmud prohibits covering lamps because it is a waste of fuel. Extending this to modern day sources of fuel, one can argue that wasting energy comes under this prohibition [6]. The charge to subdue the land is thus countered by another commandment not to cause wanton destruction.

Other Biblical commandments also contain ecological themes and invite man to protect the earth. The commandment to let the land lie fallow every seventh year, commonly known as *shemittah*, is given an ecological purpose by the *Rambam* in *The Guide to the Perplexed*: "So that the yield of the land improve from not having been planted." The commandment to chase away the mother bird before taking her eggs is given an ecological explanation by *Ramban* (Nahmanides): "For Scripture did not permit destructiveness, wiping out a species" [1]. Preservation of the land and preservation of the species become part of man's charge to guard the earth.

The modern era has witnessed much destruction to the natural ecosystems, and while human progress is integral to the mission of mankind, man must also make sure to guard the earth and protect the environment from excessive destruction. While G-d commanded Adam to subdue the earth, He also commanded His people not to cause wanton destruction. Rav Soloveitchik discusses man's potential to create: "Man must create in both the material and the spiritual realms" [6]. This balance of physical and spiritual development is reminiscent of a story of Rav Kook: When his student mindlessly picked a plant or flower, Rav Kook responded, "Believe me that all my life I have taken care not to idly pick any grass or flower that could grow and flourish, because

there is not a blade of grass in the lower realms without a correspondence in the upper realms that tells it: ‘Grow!’ Every blade of grass says something, every stone whispers some secret, every creation sings some song” [1]. Everything in the physical world

has a corresponding feature in the spiritual world. When we use our creative power in this world we must develop both its physical and spiritual aspects. Guarding the earth and its natural environment then becomes a spiritual endeavor. ■

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PLAGUE 3: MORE THAN JUST HEAD LICE

Chana Stern

“**A**nd Aaron stretched out his hand with his staff and smote the dust of the earth, and there were lice upon men, and upon beast; all the dust of the earth” (Exodus 8:14). When one thinks about the third plague of *kinim*, also known as lice, the first image that comes to mind is the Egyptians scratching their heads. However, there are several explanations for what the word *kinim* actually refers to.

Rav Avigdor Miller explained that *kinim* is the plural of *kina*, meaning louse. Therefore, *kinim* may refer to an array of parasites and pests that clung to the bodies and clothes of the Egyptians. Once they are “established” within the host, these parasites are difficult to remove and expel from the body. They even have the potential to burrow under the skin, which may cause rash, fever, nervous complications, meningitis, and a variety of other diseases. *Hashem* made the epidemic of lice even greater by increasing their rate of reproduction, from 5000 lice per couple of weeks to some multiple of that in the same amount of time. As a result, the mortality rate of the Egyptians increased to 70 percent. Rav Avigdor Miller therefore concluded, “Although usually the concept of *kinim* refers to lice, yet the term certainly includes all the parasites that attach (“establish”) to hosts” [1].

In the past several decades, there has been an emergence of many parasitical infections which come from parasites that can fall under the category of *kinim*. One such class of parasites, called *Anisakis*, has been reported in people who consume several kinds of fish including cod, sardines, and salmon. This parasite has been primarily found to grow in wild-raised fish, as opposed to the farm-raised variety, because of the ability of the parasite to lay eggs in the marine species present in natural waters. The *Anisakis* parasite has a remarkable lifecycle which begins when the *Anisakis* worm deposits its eggs in a mammal, usually a whale or dolphin. The marine mammal then excretes unembryonated eggs in the ocean which develop into embryonated eggs and are then ingested by crustaceans. Predators within the ocean such as salmon or flounder consume the host and the *Anisakis* begin to pierce into the visceral organs of the host fish. These fish are later ingested by humans and can induce harmful effects to the human

digestive tract [2].

In 1981, there were reports of parasites that have primarily affected members of Jewish Orthodox communities. The parasite that caused these problems was found to be the tapeworm, *Diphyllobothrium latum*. This parasite has spurred problems specifically among Jewish Orthodox women because they would prepare gefilte fish and taste the raw mixture. After such news emerged, many became cautious of raw fish which can cause a great deal of abdominal discomfort due to the tapeworms residing in the fish [3].

In the past several decades, there has been an emergence of many parasitical infections which come from parasites that can fall under the category of kinim.

Moreover, in 1991, there was an emergence of neurocysticercosis among four Orthodox Jewish families in New York. Neurocysticercosis is infected tissue in the brain that is induced by *Taenia solium*, a pork tapeworm. One may ask, if Orthodox Jews adhere to strict dietary laws that prohibit the ingestion of pork, how is the presence of the *T. solium* tapeworm possible among these households? The sources of infection were discovered to be the domestic employees living in these Jewish households. These domestic employees were immigrants from Central America where the tapeworm is prevalent. In a particular study, the stools of Central American immigrants in North Carolina were tested for the *T. Solium* tapeworm and it was confirmed that 4.4% of the tested population contained the tapeworm. Housekeepers who originated from Central America who handled food and were given child care responsibilities, facilitated the emergence of this tapeworm in a homogenous community where people displayed similar hiring practices [4].

According to the Soncino Edition of Exodus 8:12, *kinim* are sand flies [5]. A parasitic disease known as visceral leishmaniasis is transmitted through the bite of a sand fly and causes sores

and lesions on the skin. Many people in India and Bangladesh are affected by this harmful infection, as well as many American troops who have nicknamed the disease the “Baghdad boil.” Visceral leishmaniasis can cause detrimental health effects as it can overwhelm the immune system. It is also known as Kala azar, and it has been found to induce weight loss, an enlarged spleen, and death if left untreated. These sand flies, therefore, pose a great problem among the poor within countries of the Middle East and South Asia [6]. The presence of this parasite alludes to Rav Avigdor’s opinion that *kinim* were many different parasites, not just lice, that caused death among the Egyptians [1]. The treatment for leishmaniasis includes intravenous medicine administered once a month to affected patients. In addition, scientists

are testing alternative treatments and drug combinations for the disease including, miltefosine, used in treatment for breast cancer, and amphotericin, a fungicide [6].

Parasites are not just an ancient epidemic that affected the Egyptians during the ten plagues that G-d struck upon them. In today’s society, there are many forms of parasites that have emerged and their descriptions have been found to coincide with the words of Rav Miller who stated that *kinim* ultimately refers to an array of parasites which infected the Egyptians [2]. Although it cannot be concurred exactly which types of parasites can fall under the category of *kinim*, the parasites that affected the Egyptians were not merely head lice that caused them to scratch their heads. ■

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AN EVERLASTING IMPRESSION: INSIGHTS ON TATTOOS AND JUDAISM

Rebecca Tabaroki

Modern society heavily emphasizes individuality and the need for self-expression. People often define themselves by what differentiates them from others. While some individuals turn to specific types of clothing for self-portrayal, women often express themselves through the style of their makeup and hair. Although personal style is a common approach for self-expression, a more permanent and modern method of self-rendition occurs through the art of tattooing.

Often, when one thinks of tattoos, she imagines an individual with exaggerated and creative illustrations on her skin. Interestingly, however, tattoos have become common in the medical field, specifically in plastic surgery and cosmetics. Women with breast cancer who have had their breasts removed may opt for reconstructive surgery to regain their femininity. During such procedures, medical tattooing is sometimes done around the chest area to promote acceptance of self and closure on the breast cancer experience. Medical tattooing is also common for scar camouflaging, cleft lips, stretch marks, and patients with severe burns [1]. Another cosmetic procedure called micropigmentation, which is “sometimes referred to as permanent make-up, is a technique in which minute, metabolically inert pigment granules are implanted below the epidermis for cosmetic or corrective enhancement” [2]. These uses of tattooing allow individuals to portray themselves in the image that they desire.

Research has been done to investigate the chemicals found in tattoo inks. Many types of ink revealed toxic metals, endocrine disruptors, and a compound that has been called “one of the most potent skin carcinogens” [3]. According to the Environmental Health News, both the Food and Drug Administration (FDA) and a number of researchers have noted that colored inks often contain lead, cadmium, chromium, nickel, titanium and other heavy metals. Black tattoo inks are often made of soot, so they contain known carcinogens called polycyclic aromatic hydrocarbons (PAHs) [3]. It is evident that the toxins found in such inks can be detrimental to the genetics of the skin, resulting in melanoma or other forms of skin cancer. In spite of these dangerous reagents, many people continue to insert such chemicals into their skin for personal satisfaction.

With a growing amount of people getting tattoos each day, a question arises in the Jewish community about the ramifications for Jewish men and women who “mark” their bodies with such tattoos. It says in Leviticus 19:28 on the topic of *ketovet ka’aka*, “You shall not make any cuttings in your flesh for the dead, nor imprint any marks on you; I am the L-rd.” As modern society progressed, the literal meaning of “imprint” has been challenged. The Mishnah understood *ketovet ka’aka* to mean tattooing. It specified “*kochal*,” a blue-colored eye paint, and other colors, as the pigments used by gentiles for their tattoos (*Makot* 3:6). *Rashi* explained *ketovet ka’aka* to mean “a scratch or incision that is embedded deeply [in the skin], can never be erased, is done with a needle, and darkens [the skin] forever” (*Makot* 21a) [4].

Although in today’s society tattooing is a personal choice, during World War II, Jewish prisoners in concentration camps were inked against their will with identification numbers.

Although in today’s society tattooing is a personal choice, during World War II, Jewish prisoners in concentration camps were inked against their will with identification numbers. A serious conflict arose when dealing with the burial of a Jew who had a tattoo. Both the *Rambam* and the *Shulchan Aruch* maintained that the one being tattooed is not responsible for the sin; the tattoo artist is. This applies to the Jewish survivors of the Holocaust. However, if the person being tattooed assists in the tattooing process and welcomes the tattoo, he is guilty of the sin and is responsible for his actions (*Rambam; Shulchan Aruch Yoreh Deah* 180:2).

While tattoos are not permitted, a Jew that has a tattoo may still be buried in a Jewish cemetery. The only Jews excluded from a Jewish burial are those who have committed suicide (*Shulchan Aruch, Yoreh Deah* 345:2). This account applies to the Holocaust survivors who were marked with tattoos on their forearms. These

Jews are, in fact, permitted for a Jewish burial. Additionally, there is another misconception that Jewish people who violated various laws will be denied a Jewish burial; therefore they opt for cremation, which is strictly against Jewish law. This misunderstanding has created unfortunate circumstances, since almost no one should be excluded from burial in a Jewish cemetery. However, when cremated, the individual is denied a Jewish burial [5]. Fortunately, with the act of *teshuvah* one may repent and receive forgiveness for his sins. Thus burial in a Jewish cemetery is allowed.

Although the *halacha* strictly forbids the act of tattooing

(Leviticus 19:28), the number of individuals inking their skin continues to rise. In today's society, tattoos are becoming more common, even in the medical field, yet research has identified the toxic reagents in inks that may have detrimental health effects. Despite the lack of *halachic* basis, the misconception about tattoos and Jewish burial continues to prevail. Among other factors, Hashem may have forbid tattooing in light of its harmful effects on the body. However, it wasn't until recently that scientific experimentation showed the potential health risks of the chemicals used in tattoo inks. ■

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BENEATH THE SURFACE OF THE HEART

Rena Thomas

How much the Torah knew about medicine has been a source of dispute for decades. There are scholars such as *Ben Bag Bag* who said that the Torah contains all knowledge, and there are no *chidushim* - discoveries and insights that were unknown to previous generations. When the scholars believed that everything was written in the Torah, they believed that even if something is not understood on the *peshat* level, it was written in a deeper *derash* level. On the other hand, there are those in the scientific community who consider the Torah a religious document only; they therefore neither find nor accept scientific references in the Torah. There is much literature available on the subject supporting either side of the argument. In the *Mishnah* (*Avot* 5:22), *Ben Bag Bag* said, “search it and search it, since everything is in it.” Many scholars, such as J.O. Leibowitz, a medical historian, maintained that medicine is discussed and understood in the Torah. In this regard, there are several incidents in Genesis and in the first book of Samuel that should be focused on.

It is difficult to determine how the Torah perceived the heart and its role in the body. There are several instances where the Torah references a heart illness or dysfunction. Many scholars debate the illness that occurred, how it developed, and what current terminology could be used to identify the illness.

Genesis *perek* 45 tells part of the story of Jacob and his twelve sons. It explains that when Jacob heard that Joseph was alive in Egypt, Jacob’s “heart became weak” (Genesis 45:26). The early commentators on this passage wrote that elderly people who receive shocking (most often, unhappy) news are prone to heart attacks. A cohort study of the Danish population was conducted by the University of Aarhus and was published in October 2011. It studied parents who had lost a child of eighteen and under to determine their relative risks of heart disease. The results showed that parents who lost a child had a higher risk of heart disease [2]. Thus, it is understandable that Jacob, upon hearing the significant and shocking news of his child, experienced a change in his heart condition. *Nachmanides* (1194-1270) and *Ibn Ezra* (1097-1023) wrote regarding this passage that “his heart stood still...the pulse paused for a while,” implying that the heart stopped because of

medical reasons, not because of a miraculous interference. In the medical terminology of today, Jacob’s cardiac pathology would be described as an arrhythmia, the disruption of the regular rhythm, or heart beats, of the heart [3].

The above stories show that the Torah describes the essential role of the heart in physical life. However, there is apparently another dimension to the heart's role. The Torah also referred to the heart as the center of the human psyche.

A similar incident happened with Sarah several decades earlier, but with a different outcome. *Rashi* explained in Genesis 23:2 that the reason the death of Sarah is written right after the *akedah* (binding of Isaac) is because the two events are connected. When Sarah heard the news that her son was being sacrificed and that only at the last minute was he spared, her soul left, and she died. Here too, an elderly person (as Sarah was 127 years old at the time) received shocking news, which caused the heart to stop, either momentarily or permanently. Though *Rashi* did not describe her heart failure specifically as an arrhythmia, the similarities between her incident and Jacob’s suggest that she, too, had suffered an arrhythmia.

A second instance in which a person died from a heart failure is recorded in I Samuel (chapter 25), regarding *Nabal*, Abigail’s husband. *Nabal*, a nobleman during the time of King David, died, presumably due to a heart attack [3]. King David asked *Nabal* for wine and food for his army, but *Nabal* refused to grant King David’s request. Abigail, despite *Nabal*’s refusal to heed to King David’s request, gave the king what his army needed. When Abigail told her husband that she fulfilled King David’s request, *Nabal* was scared of King David’s revenge, and it says that “his heart died within and he was a rock” (I Samuel 25: 37). Nechama Leibowitz, a modern Biblical commentator who found the Bible very informative regarding human biology, analyzed *Rashi*’s interpreta-

tion of this incident and explained that *Nabal* had a heart attack because of the immense stress he was put under by King David. According to Leibowitz, “in this case death overcame him after ten days of great tension, perhaps, as the result of a second, and fatal, heart attack” [1].

In addition to events in the Torah that demonstrate various cardiovascular diseases, there are commandments which attempt to prevent such diseases. There are *mitzvot* that play a role in a healthy heart and a healthy life style. In Psalms, King David wrote that “who shall ascend into the mountain of the L-rd...he that hath clean hands, and a clear heart” (Psalms 24:3-4). While many take this passage as a theological statement or religious commandment, it can also be interpreted as a suggestion for a medically healthy life style. An example of a religious practice which benefits physical health is the *mikva* (ritual bath), which may even have been a deterrent to bacterial contamination associated with the black plague. The Jews in the Middle Ages may have been prevented from contracting common microbial diseases that circulated in society at that time because they were cleaner and more isolated than the general community [6]. Of course, this does not suggest that hygiene is the underlying reason for the *mitzvah*. Nonetheless, it can be an auxiliary benefit. Today, a major consequence of obesity is the risk for developing heart diseases [7]. Perhaps King David’s statement is a warning for us to keep our heart clean by not eating too many animal-derived meat products and fats and not drinking too much wine. *Nabal*, for example, is said to have drunk and eaten too much (Samuel I 25:36). Perhaps the news had such a devastating effect on him because he had a highly unhealthy life style. To take good care of the body a person needs to have certain characteristics and habits. These characteristics and habits make up the psychological aspect of the body.

The above stories show that the Torah describes the essential role of the heart in physical life. However, there is apparently another dimension to the heart’s role. The Torah also referred to the heart as the center of the human psyche. The heart can reflect emotions such as anguish (Jeremiah 23:9), wisdom (Exodus 31:6), pleasure (Psalms 9:2), and shame (Psalms 69:21). Also, the heart is described as the decision-making organ (*Leviticus Rabbah* 4:4) and as the speaker: “I spoke with my own heart” (*Ecclesiastes Rabbah* 1:16). In modern Hebrew, phrases such as “*ke’ev lev* - pain of the heart” or “*lev doev* - heart that aches” are commonly used. Clearly, the heart has a double role - one physical, one emotional. Are these two dimensions connected?

Human psychology has always played a role in human health. Psychologically a person needs relaxation. Too much stress can lead to a heart disease. A study conducted by the Department

of Environmental Medicine and Public Health has tested psychic trauma as a cause for death. The study found that an overwhelmingly emotional event played a major role in the patient’s death. [8]. The brain’s stress obviously is correlated to the heart’s health. There are several *mitzvot* that help relieve emotional stress and therefore promote a healthy life style. For example, there could be an auxiliary health benefit from a sort of Shabbat once a week where a Jew is forced to relax his body. In addition, R’ Ovadya (from Bartenura, Italy) interpreted *Pirkei Avot* 2:1 as a warning not to go to any extreme; a person should go on the “proper path” which is the middle path. This would include not over-eating, stressing too much, and getting too angry. Anger, stress, agony, and depression are feelings triggered by the brain that can affect emotional health as well as the heart’s health. Clearly then, emotional and psychological health, which are often alluded to through imagery of the heart, also affect the physical health of the heart.

There might be another reason as to why the heart is described as the center of the psyche in the Torah. The Torah’s treatment of these two dimensions of the heart brings to mind the following general aspect of the Torah. In a Jewish Ethics lecture at Stern College, Dr. David Shatz discussed differences between secular legal law and Jewish law. He demonstrated that the Torah relates to us on different levels, and he emphasized that certain elements of the Torah represent a set of values, not necessarily a set of laws the sole purpose of which is to be implemented into daily practice. He gave an example of executions that were rarely carried out by judicial Jewish courts. Even if a person had committed a sin for which the punishment was execution, he still was not executed, because G-d wanted to emphasize the severity of the sin, but not for its punishment to actually be carried out. The secular law, however, is a set of rules that are meant to be strictly obeyed; if someone disobeyed the law, the consequences were clear, with no other meanings or interpretations [5]. Clearly then, the Torah encompasses more than the mere physical dimension of life. The physical, the emotional, the intellectual, and the spiritual dimensions of life are interconnected and even parallel one another. As King David described, the Torah is complete - “*imima*” (*Psalms* 19:8).

Perhaps the Torah disclosed the significance of the heart to teach us that without this vital organ, *ruach chaim*, the body would perish. When the Torah refers, as mentioned above in Exodus (9:12) and *Midrash Rabbah*, to the heart as a thinking, feeling, and aching organ, the Torah was not mistaking the functions of the heart with those of the brain. The heart, by pumping oxygenated blood to the brain, provides the brain with the life necessary

to perform various actions and thoughts. Sherwin Nuland, in his introduction to his book *The Mysteries Within*, wrote, “As in many civilizations of the time and before, it was their presumed site of origin of thought, emotion, and everything that we moderns associate with the brain or mind” [9]. The heart “gets the credit” for

what the brain does. After all, a brain without the heart is valueless. When the Torah referred to the heart as a thinking organ it is not that it had the incorrect concept about the role of the heart, but rather it recognized precisely the significance the heart plays in our body. ■

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"LEFT" OUT OF TEMPLE SERVICE? A HALACHIC DISCUSSION ON LEFT-HANDEDNESS

Yocheved Tirschwell

We use our hands for a myriad of critical activities, such as eating and drinking, writing and typing, and playing sports. *Halachically* speaking, most people have it easy; if the Talmud says “use your right hand to put on *tefillin*,” or “don’t write with your right hand on *Shabbat*,” they just follow the rules.

On the other “hand,” what about the lefty minority? Does *halacha* change for them? By taking a closer look into Biblical and *halachic* discussions regarding handedness, one can gain a greater understanding of the nature of left-handedness and the topic’s overall complexity.

In *Sefer Shoftim* (3:15), the *pasuk* describes the judge *Ehud ben Gera* as “*iter yad yemino*”. Many commentaries quote Psalms (69:16), to explain that the word *iter* as closed or shut. Radak and others write that *iter yad yemino* here denotes a weakened use of the right hand, and, therefore, greater use of the left hand, a condition more commonly known as left-handedness. Because *Ehud* was left-handed, he strategically placed his sword on his right thigh, and was, therefore, able to take king *Eglon* by surprise and stab him in the stomach (*Metzudat David, Shoftim* 3:15). The term *iter yad yemino* comes up again later on in *Sefer Shoftim*, when an entire battalion from the tribe of Binyamin is comprised of “*bachur iter yad yemino*,” which commentaries similarly translated as “left-handed.” The Talmud also uses the term *iter yad* to refer to left-handedness, defining it as one who has weaker strength in the right hand. The Talmud states that the left hand of a lefty is like the right hand of all other people, implying that a lefty may be on the same level as a righty in terms of strength, only using a different side of the body (*Shabbos* 103b).

There are some *Mitzvot* from which a lefty is actually disqualified. The Talmud prohibits a left-handed *kohen* from serving in the *Beit Hamikdash*, referring to such a person as *pasul*, or unfit to serve. There is a discussion in the Gemara regarding an ambidextrous *Kohen*: Rabbi Yehuda claims that he is unfit, as equality in hand usage denotes that the right hand is “abnormally weak,” while the *Chachamim* hold that he is fit to serve [1].

In terms of other commandments which revolve around a particular side of the body, whether a lefty should use a different

extremity depends on the reason for each commandment. Some *halachot* require the right side of the body because it is considered more important. The Torah regards the right side as a symbol of strength and success. The Torah also uses the right side to represent G-d’s power, walking in the proper path, and as the way to salvation [2]. The Torah says that the right side takes precedence over the left side in the purification procedure performed on a *Metzora*. The *Kohen* is required to place oil and blood from a *Korban* onto the *Metzora*’s right thumb, in his right ear, and on his right foot, whether the *Metzora* is a lefty or a righty. From this commandment, the Gemara extrapolates that the right side is of great importance in many other Torah commandments as well [3].

On the other “hand,” what about the lefty minority? Does halacha change for them?

On *Sukkot*, the Gemara says that one holds the *lulav* in the right hand and the *etrog* in left, as the *lulav* is of greater importance than the *etrog*. There is a difference of opinion regarding the *halacha* for lefties. There is also a debate regarding the placement of *badassim* and *aravot* in a lefty’s *lulav* of whether they should be on the right and left respectively like a righty’s *lulav* or on opposite sides. [2].

There are other *halachot* which dictate that one must actually use the left hand, as it is weaker. To symbolize his hesitance to leave G-d’s presence, a righty removes his *tefillin shel rosh* with the left hand and starts with the left foot when stepping back at the end of the *amidah*. The *Magen Avraham* and most Rabbinic authorities conclude that a lefty performs these actions with his right hand or leg [3]. Additionally, if one writes with the hand with which he doesn’t usually write, it is considered a *shinui*, or change, and he does not violate the Biblical commandment of keeping *Shabbat*. Using the same logic as above, a lefty violates *Shabbat* only if he writes two letters with his left hand, as opposed to a righty who violates only if he uses his right [2]. Other *halachot*

such as inclining one's head on the right arm for *nefilat apayim*, blowing the *shofar* from the right side of the mouth, and removing the Torah from the ark using the right hand are all examples of laws dependent on which arm is stronger, and therefore change for lefties [2].

Sometimes the *halacha* understandably treats lefties the same as righties. We lean to the left on Seder night so our food should flow more readily through the body, because many of our organs are on the left side of the body. Lefties have the same bodily composition as righties, and therefore many *Poskim* conclude that the *halacha* here remains the same for them [3]. Similarly, a man holds his *tzitzit* with his left hand during *Shema* to be close to the heart. The law would not change for a lefty because his heart is also on the left side [2]. Also, due to the reality that the majority of people in the world are righties, a *mezuzza* is hung on the right side of the doorpost, even if a lefty is hanging it up, because most people who enter through the door are righties [3].

Scientifically speaking, what causes left-handedness? Recently, researchers found that people with a genetic component called the LRRTM1 gene are more likely to be lefties, but it is not guaranteed. It appears to influence handedness only if the gene is inherited from the father, but even then it still does not guarantee the child to be a lefty [4].

Statistically, if both parents are right-handed, there is a 9% chance of having left-handed children. For a lefty and righty couple, there is a 19% chance, and there is a 26% chance if both parents are lefties [5]. There is clearly some genetic influence in handedness, but the trait is not purely genetic. Furthermore, the Geschwind-Behan-Galaburda Theory of Left-Handedness presented in 1987 suggests that all people are supposed to be right-handed, and there is a mistake that happens to the fetus when in the womb that causes left-handedness. The theory states that because there are more men lefties than woman lefties, it must be that the chemical that causes this shift is male-linked. By testing

rats, they found that stress during pregnancy could cause fetal testosterone levels to rise. Because men naturally have high testosterone levels, an increase in testosterone in the womb could cause slow development in the left-hemisphere more for men than for women, creating more male lefties than female lefties [6].

Halachically speaking, there is also much argument in the discussion of how to determine left-handedness. The *Mishnah Berurab* holds that the side that one uses with greater ease and with which performs most tasks, legally defines his handedness (*Mishnah Berurab* 27:27). There is a debate as to whether one whose right hand has become impaired or injured is *halachically* considered left-handed. The majority of *Poskim* that discuss the idea of handedness rule that one is legally considered a righty unless he does nearly everything with his left side [2].

When it comes to donning *tefillin*, there is an argument as to whether handedness is determined by the hand that one writes with or the hand that one performs most tasks with [2]. A practical difference in the two opinions would be in one who was born a lefty and was forced to write with his right hand, as was the case for many children growing up in the mid-20th century. Though such a person becomes accustomed to writing with his right hand, his left side remains stronger, and most of his tasks are performed using his left side. If dominance depends on writing, this man would don his *tefillin* on his left arm. If, however, it depends on the hand with which he performs the majority of tasks, then he would don the *tefillin* on the right arm. As there is a difference of opinion, there is no conclusion in this situation and one must take a side in the argument.

Handedness in halacha is an extremely complex topic, and is subject to many differences in opinion. Left-handedness is pertinent to many *mitzvos*, and it is therefore essential to learn the ways in which a lefty should conduct himself. This article is not meant to *pasken*, but rather to promote interesting discussion on the topic. ■

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FROM RACHEL TO MICHAL: MATERNAL MORTALITY IN TANACH

Helen Ayala Unger

In the recent past, medical breakthroughs have improved the quality of life possible for patients with dozens of different ailments. The polio vaccination, for example, has wiped out up to 99% of polio cases worldwide since its development in 1988 [1]. Laparoscopic surgical techniques, introduced to the United States in 1972, have reduced the infection risk associated with intestinal, gynecological, and many other surgeries [2]. Another area in which modern medicine has had great influence is the process of childbirth; thankfully, in today's times, a healthy and safe delivery for both mother and child is the norm. Obstetric sonography, newly developed drugs, fetal monitoring systems, and—if needed—surgical interventions have ensured that not only will the baby enter the world in good condition, but that the mother will have as short and painless an experience as possible. This, however, has not always been the case. In Biblical times, without advanced medical knowledge, giving birth was, paradoxically, a threat to the mother's life. In fact, several cases exist in *Tanach* of the mother's death during childbirth, due to varying medical causes. This article's aim is to explore the medical causes of maternal mortality found in *Tanach*.

One of the most famous cases of maternal mortality in the Bible can be found in *Sefer Bereshit*, *perek* 35. Yaakov and his family journey from *Beth-el*, when the pregnant Rachel goes into labor with her second child:

“They journeyed from *Beth-el* and there was still a stretch of land to go to *Ephath*, when Rachel went into labor and had difficulty in her childbirth. And it was when she had difficulty in her labor that the midwife said to her, ‘Have no fear, for this one, too, is a son for you.’ And it came to pass, as her soul was departing—for she died—that she called his name *Ben Oni*...” [3].

An intriguing fact can be gleaned from these *p'sukim*. As is noted in several biblical journals, the midwife's comment that Rachel was delivering a boy, said during Rachel's “difficulty in labor,” that is, her active labor, could only have been made if the fetus was presenting itself in a breech position, with the fetus's head emerging from the womb last, instead of first, as is considered medically normal [4, 5]. Additionally, the fact that Rachel's “difficulty” in labor is highlighted in the *pasuk* hints that Rachel may

have experienced mid-labor obstetrical complications, such as dystocia, which can come about during a breech delivery and will be discussed later in this article.

Thankfully, in today's times, a healthy and safe delivery for both mother and child is the norm.

Another case of an apparent breech birth can be found in *Sefer Shmuel I*, after the defeat of the Israelites by the Philistines. The wife of Pinchas, never mentioned by name, hears news about the capture of the Ark and of the deaths of both her husband and father-in-law, and she immediately goes into premature labor as a result of the shock. The *Sefer* then tells of her death: “As she was about to die, the women that stood by her said unto her: ‘Fear not; for thou hast brought forth a son.’ But she answered not; neither did she regard it...” [6]. Similar to the story of Rachel, the determination of the baby's gender during labor would only have been possible had the fetus been in a breech presentation. It is likely that *Eshet Pinchas* suffered the same types of obstetrical complications as Rachel, leading to her death.

When a fetus is in the breech position *in utero*, several complications may occur during the birthing process that can harm both the mother and the child. For the fetus, umbilical cord prolapse, the compression of the umbilical cord which leads to decreased oxygen flow to the fetus, can occur, as can injuries to the brain and skull due to the rapid passage of the head through the mother's pelvis. On the mother's side, the breech presentation brings with it the risk of dystocia, an abnormally difficult labor brought on by uncoordinated uterine activity and/or abnormal fetal presentation. Dystocia can lead to obstructed labor and an increased risk of birth-related injuries [7].

A more immediately life-threatening complication, which many scholars believe was the cause of death for both Rachel and *Eshet Pinchas*, is hemorrhaging caused by either a uterine rupture or cervical tear. Uterine rupture, defined as any breach in

the uterine walls incurred during labor, can cause fatal internal bleeding in the mother. In Rachel's case, uterine rupture was likely, as she had been infertile for a long period of time before giving birth to Yosef and Binyamin, and the risk of rupture during labor increases with age. A cervical tear incurred during the delivery of the fetus's head during a breech birth can cause considerable blood loss and be deadly as well. Another possibility is that the two women suffered from an obstetrical complication often associated with breech-presenting fetuses termed placenta praevia. This condition is defined as an attachment of the placenta to the uterine wall either close to or covering the cervix; left untreated, placenta praevia causes antepartum hemorrhaging and can kill both mother and fetus [8,9].

In today's time, approximately 25% of fetuses are in the breech position at 32 weeks gestation, with the number dropping to about 3% by the time of birth [10]. In the majority of cases in the United States, breech babies are delivered by Caesarian section to avoid both the complications discussed, and the possible need for forceps- or vacuum-assisted delivery, which can result in brain and organ damage to the fetus. In order to avoid breech birth entirely, modern doctors may employ a technique called the external version method. The external version method allows physicians to non-surgically turn breech-presenting fetuses to the normal birth position by applying gentle pressure on the lower abdomen after

administering drugs to the mother that cause her uterine walls to relax [11]. None of these tools or alternative options, needless to say, were used in biblical times, making a breech birth a highly perilous event in those days.

Other stories of maternal mortality can be found in *Tanach*, in addition to the accounts of Rachel and *Eshet Pinchas*. Michal, the daughter of Shaul and wife of King David, mocked her husband after seeing him dancing in public, and it was afterwards written that she "had no children until the day she died" [12]. The Talmud, in *Sanhedrin* 21a, interprets this as indicating that Michal died in childbirth. Additionally, in *Megillah* 13a, it is noted that the mother of Queen Esther also passed away in childbirth. No additional information is provided regarding either case, and thus their deaths may be attributed to a myriad of causes that are beyond the scope of this article.

The birth of a child is an extraordinary process in which the providence of G-d can often be perceived. In the biblical age, however, this process was fraught with danger for both mother and child, as medical knowledge was limited and no interventions were possible for birthing women. With today's advanced technology, it is easy to forget just how risky childbirth can be. The cases of maternal mortality in *Tanach*, such as those of Rachel and *Eshet Pinchas*, can serve as a humbling reminder of the miracle that is childbirth. ■

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HOW IS DEATH DEFINED? A FOCUS ON BRAIN DEATH

Gabrielle Weinberg

The idea of death can be a very sensitive topic for many. The exact time that a person has passed away is also a very delicate and, more importantly, controversial topic in both the Jewish and secular worlds. According to Judaism, the human life is infinitely valuable. It is so valuable, in fact, that if someone were to prevent a person from living for even a single moment, he would be considered a murderer. It is for this very reason that the point at which a person dies should be carefully and thoroughly defined. This definition must follow not only *halacha* (Jewish law), but it must constantly be redefined and aligned with new medical knowledge, procedures, and standards [1]. So, how is death defined by *halacha*? According to Rabbi Soloveichik, *halacha* defines death by the cessation of three vital processes: respiration, cardiac activity, and brain activity [2]. It is debated, however, if *halacha* recognizes brain death alone, even though there is continued cardiac activity [3].

One first must consider the medical and legal views of death. Let us first examine the legal view. The legal view of death incorporates the medical views on the subject. In 1981, the Uniform Determination of Death Act was passed by the President's Commission for the Study of Ethical Problems in Medicine and Biomedical and Behavioral Research. This Act clearly defined when it is permissible to declare a patient dead. It read, "An individual who has sustained either: 1) irreversible cessation of circulatory and respiratory functions or 2) irreversible cessation of all functions of the entire brain, including the brainstem. The declaration of death must be made in accordance with acceptable medical standards." In other words, no matter what the reason is for the cessation of breathing or the heart pulsing, the patient is deemed dead. The second and newer requirement refers specifically to the brain. The requirement is that the whole brain must stop working - both the upper left and upper right hemispheres, as well as the brain stem [4].

There is a list of guidelines for defining death the President's Commission. These guidelines require irreversible loss of function within the heart, lungs, and brain. Cessation of the heart and lungs is examined through commonly accepted medical procedures. Irreversibility within this cardiopulmonary category is

described as complete cessation of function, in addition to the patient being unresponsive to any treatments. Neurological cessation includes complete malfunction of cerebral and brain stem processes. Brainstem malfunction is determined when a doctor asserts that gag reflexes and certain eye reflexes, known as cephalic reflexes, are damaged. This examination also includes apnea testing, which confirms that there is no ability to breathe. The apnea

Is it possible under halacha that brain death alone can be sufficient evidence of human death?

testing ensures that there can be no possibility of spontaneous breathing, which is controlled by the brainstem; thus, the apnea test confirms the death of the brainstem. Irreversibility within the neurological category consists of three factors: there is no chance of recovery, unresponsiveness to treatment, and a cause for the dysfunction of the brain is clearly defined and is adequate enough to explain the reason for brain dysfunction. It is important to rule out any possible medical conditions that mimic brain death, such as drug overdose and kidney failure. So long as the patient demonstrates cessation and irreversibility in either the cardiopulmonary or the neurologic categories, the patient is legally dead [4].

One may wonder what kind of testing can confirm brain death. Three criteria indicative of brain death are: (a) coma and total non-reactivity to painful stimuli; (b) total absence of brain stem reflexes; and (c) total absence of spontaneous respiration, or apnea [5]. Various technologies are used to assess brain death. One method, though it cannot be used as a sole diagnostic source, is through an electroencephalogram, or EEG, which measures only the electrical activity in the upper brain. It is for this reason that an EEG cannot completely confirm brain death, as it excludes measuring the electrical activity within the brainstem. However, the EEG can be of some probative value if the test is performed by a physician who has had many years of experience with the EEG. Yet another test, done by performing cerebral blood flow studies to confirm that the brainstem is dead, determines whether the

brain and brainstem are receiving an adequate degree of blood flow. This is done through cerebral angiography, which injects dye into the four major blood vessels leading to the brain. Once the dye is injected into these veins, it is possible to determine if there is any blood flow to the brain. This procedure, though quite accurate in diagnosing brain death, is not commonly used, as it is impractical, and puts the patient at risk, as it involves transporting him outside his room to another part of the hospital [4].

How is brain death defined *halachically*? Is it possible under *halacha* that brain death alone can be sufficient evidence of human death? It was not until about thirty years ago that the accepted Jewish concept of death included brain death. Before this point, one was considered dead when the heart had stopped beating and the person stopped breathing. This thought is related to a Talmudic (*Yoma* 85a) discussion stating that it is permissible and obligatory to desecrate *Shabbat* to save a human life. The example used is of debris falling onto a person during *Shabbat*.

If a building collapses on the *Shabbat* and someone may be trapped in the rubble, one must desecrate the *Shabbat*, if necessary, to try to save the victim. If one finds him alive, one extricates him and tries to save his life. If he is found dead, one leaves him there until after the *Shabbat*. How far does one dig to determine whether the victim is dead or alive? Up to the nose! An additional view is up to the heart. The main sign of life is in the nose, as it is written: ‘all in whose nostrils is the breath of the spirit of life’ (Genesis 7:22).

Thus, one should break *Shabbat* and take the debris off the person’s body, even though it is most likely that the person is, indeed, dead. In other words, the possible preservation of life trumps the rules of *Shabbat*. It is only until the rescuer is sure that the victim is dead that the rescuer can no longer break the laws of *Shabbat*. The rescuer can be certain that the victim is dead by removing the debris until the victim’s nose is unobstructed and then can determine whether the victim is breathing or not. The later view of this case mentioned that the body should be removed of the debris up to the chest; if the rescuer does not find a heartbeat, the victim is considered dead. This, however, is the less supported view, as sometimes a heartbeat can be so faint that it goes unnoticed [3].

As noted by Rav Avraham Steinberg, there are various rabbinic interpretations of this pivotal Talmudic passage [5]. Some rabbinic authorities maintained that a person is clinically dead and is considered a corpse when it is clearly evident that respiration has ceased. The notion of defining death by the absence of respiration can be rooted to a statement in the Torah that reads, “...all in whose nostrils is the breath of the spirit of life [Genesis 7:22].”

Interestingly, as the roots of Hebrew words often hold the secrets to their definitions, the Hebrew word for soul, *neshama*, very much resembles the Hebrew word for respiration, *neshima* [1]. The other Talmudic view of “up to the heart” has been interpreted as “up to the navel,” perhaps an indication of abdominal respiration, rather than cardiac activity. Other Rabbis maintained that cessation of respiration is only one criterion that then must be combined with other clinical signs, such as the cessation of heartbeat and peripheral pulses. Accordingly, death may be defined as the termination of respiratory and cardiac functions. Some consider cessation of respiration to be the *definition* of death and therefore if there is no breathing, the person is legally dead. Others consider termination of respiration to be a symptom of death, but the definition of death is really cardiac function. Another opinion is that although respiration is the main sign of life, if other signs of life are observed in other organs, the lack of respiration by itself cannot establish death. In other words, the Talmudic passage from *Yoma* is interpreted differently by different rabbinic authorities [5].

How is brain death viewed according to *halacha*? Rav Steinberg noted that brain death represents the “irreversible cessation of brain and respiratory functions” and has many diverse causes, including head trauma, malignant brain cancer, metabolic disturbances, massive intracranial bleeding, and the failure of vital organs [5]. It is beyond the expertise of this writer to explore the various rabbinical opinions regarding brain death. Most rabbinic discussions, however, revolve around another Talmudic passage (*Ohalot* 1:6): “People who are beheaded, however, convey impurity as corpses, even if they are still moving convulsively. The latter is considered only a postmortem reflex action, like the tail of a lizard which moves convulsively.” Rav Steinberg cited the Rambam (*Tum’at Met* 1:15) who continued, “So, too, someone with a broken neck with most of it severed, or whose back is ripped open like a fish, or who is decapitated, or whose body is cut in half at the abdomen conveys ritual impurity even if one or more organs or limbs are still shaking” [5].

Again, rabbinic decisors maintain various positions. Some Rabbis concluded that any person close to death, lacking cognition, and who cannot survive is considered dead. Other Rabbis required full decapitation, so that the brain and body are no longer connected, indicating that any subsequent convulsive shakings were not indicative of life. Here, the stress is on the state of the body: an intact body is indicative of life, whereas decapitation alone is not indicative of death, but rather is important in issues of the laws of purity and impurity, as such an individual is considered to be a corpse. Finally, there are those who maintain that decapitation is an absolute and irreversible indication of the de-

struction of brain functioning. Any patient with absolute and irreversible destruction of the brain, even if not actually decapitated, is defined as dead or as “physiologically decapitated.” This correlation between decapitation and modern cases of brain death is accepted by Rabbi Dr. Moshe David Tendler and others but is not accepted by all [3].

In compliance with the Talmudic (*Yoma* 85a) definition of death being that a person cannot spontaneously breathe and appears to be dead, permanent and complete damage to the brain covers this definition of death. Rabbi Moshe Feinstein, who strongly supported the traditional Jewish view of death being the termination of breathing, asserted that “by injecting a substance into the vein of a patient, physicians can ascertain that there is no circulation to the brain - meaning, no connection between the

brain and the rest of the body - that patient is legally dead in Judaism because he is equivalent to a decapitated person.” The procedure being referred to is a cerebral angiography, the test to measure blood flow to the brain. Dr. Fred Rosner, following this logic, noted that brain death is the only reasonable definition of death [3].

Both *halacha* and medicine modified their definitions of death to include brain death or interminable brain cessation as a critical factor in the determination of death. Both agree with the basic idea that death can be defined as either the permanent failure of cardiac activity and respiration or the complete cessation of brain activity. Both also seem to take upon the extra stringency of making sure that all three vital processes must be nonfunctional in order for a human to be legally and medically considered dead. ■

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HER SISTER'S KEEPER

Anna Weinstein

“**A**braham was one hundred years old when his son *Yitzchok* was born to him. Sarah said, ‘G-d has given me laughter. All who hear will laugh with me’” (*Bereishit* 21:6). The *Midrash* explains that *Yitzchok*’s birth did not merely mark the end of Sarah’s infertile journey; when her prayers for motherhood were answered, so were those of many other childless women. According to this interpretation, Sarah’s delivery filled the world with joy, but on the grander scheme, it served to dichotomize a recurrent theme in Judaism: the sorrow of barrenness and the bliss of childbirth.

Today, the birth of a Jewish child is one of the greatest reasons for family and community members to rejoice, gather together, and celebrate over a new blessing. Whether relatives and friends recite *tefillot* (prayers) at the *brit millah* (circumcision) of a boy or *zeved habit* (naming ceremony) of a girl, the spirit of celebration inevitably radiates from the house of a newborn child. There are families, however, that are not as fortunate as to share in Sarah’s “laughter.” Some children are born with devastating health complications and abnormalities, facing early medical hardships and health complications. One such family, a young Orthodox Jewish couple, turned to *Rav* Moshe Feinstein in 1977 for advice regarding the alarming fate of their newborn conjoined twins [1].

Twinning is the result of two possible scenarios. One scenario occurs when a woman releases two eggs and each is fertilized by separate sperm, which results in fraternal twins [2]. The other common twin type, identical twins, is the result of a single fertilized egg splitting completely and developing into two fetuses. The split usually occurs within twelve days after conception, and according to the “fission theory,” if it delays until after the twelfth day, separation never reaches completion [3]. Conjoined twins are thereby formed. Depending on the extent of the egg splitting, as well as how late in the process it occurs, twins are joined at various places. There are three major classifications of conjoined twins: thoracopagus, omphalopagus, and craniophagus [2]. The third is the rarest case, wherein the twins are joined at the cranium or head, accounting for only two percent of incidents. Omphalopagus twins are attached from the breastbone to the waist and share liver, gastrointestinal, or genitourinary functions, making up to 33

% of the conjoined twin pool. Thoracopagus twins are connected at the upper portion of the torso and share a heart. Averaging at 40 % of conjoined twin cases, such twins are the most common and often the most difficult to operate on.

The ruling in this case is not merely an exciting finale to a series of mind-boggling debates. It is an exemplary module of how Torah meets science in a world that often views the two as mutually exclusive.

Rav Moshe Feinstein, a great Torah sage and *halakhic* expert, was consulted as to whether or not Jewish law would permit the separation of the pair of thoracopagus twins, who shared a six-chambered heart [4]. In the case brought to *Rav* Feinstein, one of the babies, called Baby Girl B, had an essentially normal four-chambered heart which was fused to the stunted, two-chambered heart of her sister, termed Baby Girl A. Leaving the twins conjoined meant a certainty of heart failure and the death of both. Dividing the hearts among the twins was far too dangerous, according to medical experts at Children’s Hospital of Philadelphia; the connecting wall of the hearts, found alongside the left ventricles, was too thin to withstand division, and Baby Girl A had a highly unlikely chance of survival with one half of a normal heart. Dr. Henry L. Edmunds Jr., the renowned hospital’s chairman of cardiothoracic surgery, decided to put all six chambers into Baby B’s chest [4]. Such a surgery meant life for Baby Girl B and death for Baby Girl A. The twins’ parents entrusted *Rav* Moshe Feinstein, his son-in-law, Rabbi Dr. Moshe Dovid Tandler, Ph.D., and the latter’s son, Rabbi Dr. Yaakov Tandler, M.D., to make a critical judgment call: was it *halakhically* acceptable to save Baby Girl B at the expense of Baby Girl A?

The rabbis argued every night for a week until a consensus was reached [4]. By drawing references from Talmudic law, they were able to analyze the medical anomaly through a Torah-based perspective. One of the key concerns was whether or not Baby

Girl A was a *rodef*, or a pursuer, of Baby Girl B. The *din rodef*, the law that mandates a bystander to stop a pursuer, even by means of killing, is established in the Tractate *Sanhedrin* in the Babylonian Talmud (*Sanhedrin* 73a). One of the many sources that supports this obligation is found in the book of *Vayikra*, when *HaShem* says to Moses, “לֹא תַעֲמֹד עַל דַּם רֵעֶךָ,” “don’t stand aside on the blood of your fellow” (*Vayikra* 19:16). Before permitting the surgery, it was imperative that Rabbis Moshe Feinstein, Yaakov Tendler, and Moshe Tendler collectively define Baby Girl A as tantamount to a *rodef*, in which case it would be *halakhically* acceptable to give her two-chamber heart to Baby Girl B [4].

Generally speaking, the Torah allows abortion only in the event that the fetus poses a direct life-threat to the mother (*Oholot* 7:6). Since a fetus is still completely dependent on its mother for survival, if it puts its mother at risk for death, the fetus’ existence is analogous to that of a parasite with the intention to kill [1]. The rabbis compared this scenario to that of the twins and tried to establish a correlation between the role of the fetus and Baby Girl A. If the latter was perceived as “pursuing” the segment of heart that really belonged to Baby Girl B, it would be obligatory by the Torah to allow the surgery. However, there is an exception to the rule in the Talmud: if the fetus’ head is already out of the mother’s birth canal, they are considered to be two people, each with an equal opportunity to live (*Oholot* 7:6). Neither is deemed a *rodef* and “biblical ethics demands that you take a hands-off policy.” The rabbis tried arguing this scenario, since Baby Girl A and B, though conjoined, had separate nervous systems and were, in fact, two babies. The application of this interpretation would forbid separation on the account that it is an equal struggle, during which the twins make “an independent claim to life”. Interference, such as by surgery in this case, is prohibited as it would be considered the forfeit of one life for another [4].

The rabbis then referred to a parable of two men jumping out of a burning airplane, each anticipating his parachute to open and deliver him safely to the ground. The second man’s parachute remains shut, so he grasps on to the first man’s foot; however, the parachute proves too small to maintain the weight of both men and suddenly they both find themselves plunging to their deaths. Regarding such an incident, the rabbis agreed “it is morally justified” for the first man to kick off the second because he is a

rodef who threatens the first individual’s life. Also, since it was the parachute of the second man that did not open, it is he who was “designated for death,” and not his friend. Applying this excerpt to the case of Baby Girl A and Baby Girl B, the first man’s parachute is analogous to Baby Girl B’s heart, making Baby Girl A the *rodef* who clings to her sister’s heart, thereby threatening Baby Girl B’s chance at survival. The rabbis were concerned that perhaps Baby Girl A was indeed “designated for death,” as was the jumper whose parachute did not open. If she could have survived with a two-chamber heart, the rabbis would have had reason to oppose the surgery; be that as it may, Baby Girl A’s fatality with one-half of a conjoined heart was ineluctable [4].

Saving a Jewish life is an unparalleled *mitzvah* according to Torah law. Often referred to as *pikuach nefesh* (*Erwin* 45a) or the obligation to save a life in jeopardy, this *mitzvah* prevailed in *Rav* Moshe Feinstein’s ruling [4]. In the case of the thoracopagus conjoined twins, Baby Girl A and Baby Girl B, rabbinical approval for separation of the twins by surgery was granted [1]. The surgery was successful and entailed minimal complications; as was predicted, Baby Girl A did not survive. Dr. C. Everett Koop, the chief surgeon at Children’s Hospital of Philadelphia, built a commodious chest around Baby Girl B’s six-chambered heart, sewed up the incision, and attended a press conference for several reporters who anxiously awaited the post-surgery update [4].

The ruling in this case is not merely an exciting finale to a series of mind-boggling debates. It is an exemplary module of how Torah meets science in a world that often views the two as mutually exclusive. The ongoing partnership between the rabbis and doctors, defined by communal respect and appreciation, is iconic of a kinship we must embrace. Rabbi Dr. Samuel Belkin, the second president of Yeshiva University, said in his inaugural address, “We prefer to look upon science and religion as separate domains which need not be in serious conflict and, therefore, need no reconciliation. If we seek the blending of science and religion and the integration of secular knowledge with sacred wisdom, then it is not in the subject matter of these fields but rather within the personality of the individual that we hope to achieve the synthesis” [5]. Such is the harmony the students at Stern College for Women experience in their ambitious journey through the rigorous study of science and sacred texts of Torah. ■

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THE TAY-SACHS MUTATION: AN ADVANTAGE FOR CARRIERS?

Temima Wildman

Tay-Sachs is a recessive genetic disease characterized by a mutation in the gene coding for the enzyme hexosaminidase-A. Normally, hexosaminidase-A breaks down fatty acids in nerve cells but when the enzyme is defective, there is a build up of fatty acids called gangliosides. This build up interferes with normal biological processes and children with this disease usually die by age four. Tay-Sachs has a high incidence in the Ashkenazi Jewish community, with a carrier frequency of 1 in 27 [1, 3].

Puzzled by the high frequency of the Tay-Sachs mutation within the Ashkenazi population, scientists searched to find an explanation. Several theories have been proposed, some of which have resulted in great controversy. Most of the theories have a historical foundation, and are based on the status or conditions of the Jewish population during the past 900 years [2]. Because of the varied possible origins for the Tay-Sachs mutation, much uncertainty and division exists among researchers concerning an explanation for its elevated frequency within the Jewish population.

In 1962, Myriantopoulos and colleagues proposed the idea of heterozygote advantage as an explanation for the high frequency of the Tay-Sachs mutation among Ashkenazi Jews [3]. In typical Mendelian genetics, a given gene can exist in one of two forms, either dominant wild type or mutant recessive. An individual normally has two copies of each gene. “Dominant homozygous” refers to a genotype possessing two copies of the wild type allele, while “recessive homozygous” usually indicates a genotype that possesses two mutant alleles for a given trait. A heterozygote, therefore, is an individual who possesses one wild type allele and one mutant allele for a given gene, but only exhibits characteristics of the dominant allele. Heterozygote advantage is a phenomenon in which a heterozygote has higher fitness than an individual with a homozygous dominant or recessive genotype [4]. A well-known example of heterozygote advantage is that of carriers of sickle cell anemia. Studies have shown that individuals who have one allele for sickle cell have a greater resistance to malaria. Therefore, in addition to not being affected by the sickle-cell disease, the heterozygote condition (i.e. being a carrier) has an added advantage in that it provides a higher resistance to malaria [2, 4, 5].

In the case of Tay-Sachs, it was proposed that being a carrier for this disease could provide greater resistance to tuberculosis (TB) [6]. Historically it was shown that Jews have a lower rate of TB as compared to their non-Jewish counterparts living in similar conditions. Myriantopoulos suggested that there is a link between TB resistance and the high frequency of Tay-Sachs alleles [6]. However, in 1981, Spyropoulos and colleagues published an article challenging the link proposed by Myriantopoulos. Spyropoulos and colleagues performed a similar study to Myriantopoulos, investigating the causes of death for grandparents of carriers and noncarriers of Tay-Sachs in order to assess whether the grandparents of the noncarriers died from TB more often than those of carriers. The difference in the frequency of death due to TB was not significant, and therefore there is no link between the heterozygous genotype with a mutant Tay-Sachs allele and resistance to TB [6].

Because of the varied possible origins for the Tay-Sachs mutation, much uncertainty and division exists among researchers concerning an explanation for its elevated frequency within the Jewish population.

Instead of attributing the high frequency of the Tay-Sachs allele to natural selection in favor of individuals resistant to TB, Spyropoulos suggested that it is due to the founder effect and genetic drift, phenomena proposed by earlier researchers as well [6]. The founder effect occurs when a single individual with a specific mutation is the sole progenitor of a new population. As offspring are produced, more individuals will have the mutation. This results in an increase in the frequency of the mutation with each generation, known as genetic drift [5]. According to this view, the Tay-Sachs mutation occurred by chance and its frequency among Ashkenazi Jews increased because of the establishment of many new communities in the 13th century in Eastern Europe [2]. Ad-

ditionally, because of persecution against Jews throughout Jewish European history, genetic drift occurred.

Tay-Sachs is one of four genetic diseases common among Ashkenazi Jews that is related to sphingolipid disorder. All four of these diseases, Tay-Sachs, Gaucher, Neimann-Pick, and mucopolipidosis type IV, are caused by a mutation in different enzymes that affect the cell's management of sphingolipids [2, 5]. This scientific fact weakens the likelihood that the mutation occurred merely by chance, thereby strengthening the case for some advantage in being a carrier. Perhaps carrying one mutated allele offers some benefit other than resistance to TB and inheritance of the recessive disease is a by-product of heterozygote advantage [2, 5].

Although the advantage of the Tay-Sachs mutation in providing TB resistance was debated and possibly disproven, the support for the view of a heterozygote advantage did not subside. Instead, a different advantage for heterozygosity was proposed. Historically, as a result of persecution, Jews often were banned from many professions. In order to make a living, Jews had to excel intelligently and think of new ways to earn a living. Because of this, natural selection led to the survival of the smartest Jews. Furthermore, some researchers suggest that smarter men had increased reproductive success because men with greater intellectual abilities married wealthy women and had many children, passing down the "intelligence gene" to many offspring [2].

The cause of the high frequency of genetic mutations in the Jewish population has been hotly debated more recently as well. Researchers at the University of Utah built upon this historical idea and tested the theory that carrying an allele for Tay-Sachs was a result of natural selection for enhanced intellectual ability. Gregory Cochran and Jason Hardy of the University of Utah proposed that not only were Jews barred from the common professions during medieval times, but they were restricted to positions of management, which required a lot of intellectual acuity. Furthermore, those who were successful had more children, causing an elevation in the frequency of the gene that promotes intelligence [5].

Cochran and Hardy substantiate their argument by explaining that sphingolipid disorders promote growth and connections between brain cells, enabling faster communication between different areas of the brain [5]. Throughout history, Jews have been recognized for their great academic accomplishments and

groundbreaking discoveries. Statistically, Jews make up a very small percentage of the world, yet they have won 27 percent of America's Nobel prizes [5]. While these facts support the suggestion that Jews tend to be smarter, they do not prove that increased intellectual ability within the Jewish population is due to an allele for the Tay-Sachs mutation.

On the other hand, Dr. Neil Risch, a geneticist at the University of California, is a proponent of the founder effect as the cause for the high frequency. Dr. Risch found that many of these genetic diseases arose around the same time, most likely due to the same cause. Therefore, founder effects must be the reason that the mutations are so common among Ashkenazim. Other researchers disagree with the heterozygote advantage as an explanation for increased intelligence because it is far-fetched and challenging to prove.

Each view answers some of the mysteries of Jewish genetic diseases, but still leaves scientists unfulfilled with respect to other puzzling factors of these phenomena. We may never be able to pinpoint how the Tay-Sachs mutation arose. However, it is important not only to focus on the origin of the disease, but also how the disease takes its course. This knowledge will help us work toward the future and find solutions that prevent the disease from being passed to offspring.

Another question can be raised with regard to the correlation between heterozygosity for the Tay-Sachs mutation and increased intelligence. If individuals with one copy of the mutated gene have an added dose of intelligence, do individuals with two copies of the mutated gene have two doses of added intelligence? It is probably impossible to answer this question, as children with Tay-Sachs die at a young age, before their intelligence can be evaluated. However, the possibility suggests that there is much more research to be done in order to properly evaluate and understand genetic disease.

It is my hope that understanding the possible benefit of being a carrier for Tay-Sachs may lessen the stigmatization that sometimes occurs when someone is found to be a carrier of a genetic disease. Although it is not recommended to reproduce with someone who has an identical mutation, as there is a 25 percent risk of having an affected child, being a carrier should not be looked at as a flaw. It is a physical attribute of a person just like eye color, and may even carry with it the added advantage of increased intelligence. ■

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ELI'S EYES

Bella Wolf

Visual impairments such as the development of cataracts or glaucoma are fairly common occurrences in elderly people and can lead to blindness if not treated. Fifteen percent of elderly people experience visual impairment, and the prevalence of blindness is 100 times greater for people over the age of 65 compared to children in the same society [1]. Through the development of scientific technology and modern medicine, many ocular impairments can be easily treated, effectively enhancing eyesight and preventing blindness. Such technology, while inconceivably helpful, has led to a general decrease in the population's acknowledgement of the severity that comes with visual impairments. Many take for granted the advancements of science and medicine, and simply accept that many physical impairments, such as the onset of cataracts, can simply be fixed with procedures such as laser eye surgery.

Visual impairment of the elderly plagued our forefathers thousands of years ago. The remedies used to treat visual impairment employed coriander leaves, which, when applied to the eye, reduced inflammation. This is the extent to which science and ocular medicine had developed in those days [2]. Visual impairment affected many important individuals noted in *Tanach*, one of whom was *Eli* who was a high priest before the building of the first *Beit Hamikdash* and was also a *shofet*, or judge. *Eli*, during this time, was considered to be the leader of *B'nei Yisrael*. The *Tanach* states: "Now *Eli* was ninety and eight years old; and his eyes were dim, that he could not see" (I Samuel 4:15). The *Malbim* created a connection between *Eli's* visual impairment and his eventual death, which occurred when he discovered that the *Aron Kodesh* was taken by the *P'lishtim* in a war against the Jews. In fact, the *Malbim* argued, *Eli's* visual impairment contributed to his death. The news of the crushing defeat of *B'nei Yisrael* in the war against the *P'lishtim* and of the loss of the *Aron* dawned on the Jews slowly and in stages. Since the bearer of bad news arrived in the city with dirt upon his head and his clothes torn, both of which are symbols of mourning, *B'nei Yisrael's* defeat was apparent and allowed for the Jews to prepare themselves for the confirmation when the messenger eventually spoke. However, *Eli* could not see these signs of mourning on the messenger, and therefore the on-

slaught of information that appears in the next *pasuk* was enough to shock *Eli* so much that he fell from his chair and died (*Malbim*, I Samuel 4:15).

The advancement of science allows one to reevaluate the story of *Eli's* death and to determine what exactly led to the dimming of his eyes. While it is impossible to go back to that time and monitor the actions and environment in which he lived, one can analyze the *Tanach* for clues as to what may have caused *Eli's* symptoms. First, it is important to note that in *Eli's* case, the *pasuk* states that his visual impairment developed in his old age, implying a gradual loss of vision. This excludes sudden causes of blindness such as retinal detachment in which the retina becomes detached from its underlying support tissue and ischemic optic neuropathy in which loss of blood flow to the optic nerve results in its deterioration in structure and function [1].

While most cataracts are bilateral and occur in both eyes, cataracts often form more rapidly in one eye than the other [1], which would explain why *Eli* had only begun to lose vision in one eye rather than two.

The next question in analyzing *Eli's* eye condition is whether his loss of vision affected one or both eyes. This question cannot be answered definitively but may be alluded to in the discrepancy between the *keri u'ktiv* (the way the verse is written versus the way it is supposed to be read aloud) in the Biblical text that described the dimming of his eyes (I Samuel 3:2). The word "*einan*" is used when discussing *Eli's* eyes. The *keri*, the way the word should be read aloud, has two *yuds* while the *ktiv*, the manner in which the word is written, has only one *yud*. According to a basic understanding of Biblical Hebrew grammar, the *keri* refers to both of *Eli's* eyes, while the *ktiv* refers to only one eye. The *Radak* notes that since the *ktiv* only uses one *yud* it refers to a singular eye, more

precisely *Eli's* inner spiritual eye. The dimming of his spiritual eye indicates that his *ruach hakodesh* was weakened, and he began to lose the ability to receive *nevuah*. While the *Radak* explains the *ktiv* by describing a spiritual phenomenon, a scientific explanation for the mention of one eye is that *Eli* only lost his vision in one eye. If this is the case, it is possible that *Eli* developed a cataract in one eye, which led to loss of vision. While most cataracts are bilateral and occur in both eyes, cataracts often form more rapidly in one eye than the other [1], which would explain why *Eli* had only begun to lose vision in one eye rather than two. A cataract is caused by clouding that develops in the lens of the eye and causes obstruction of light through the lens, which can lead to unclear vision or blindness.

The possibility that *Eli* developed a cataract in one eye brings up a few further questions. First, why mention in the fourth *perek* that *Eli* could not see when it was just mentioned in the previous *perek*? Second, if according to the explanation in the third *perek* that *Eli* was only losing sight in one eye, he would still be able to see well enough to discern the signs of mourning on the messenger, which would have reduced the shock when informed about the capture of the *Aron*, in which case *Eli* would not have died (according to the interpretation of the *Malbim*). The answer to this again appears in the word “*einan*.” When the word “*einan*” is used in the fourth *perek*, there is no *kri u'ktiv*, and it is written exclusively with two *yuds*. This explains many of the difficulties by indicating that at this later point in time, *Eli* had lost

sight in both eyes due to development of cataracts. In the third *perek*, *Eli* is assumed to be no older than seventy, due to the fact that *Shmuel* is described as a *na'ar*, meaning a child before the age of Bar Mitzvah. While being seventy may be considered old, it would explain why *Eli* only began to lose eyesight in one eye, as analyzed by the *kri u'ktiv*, because he only died much later, at age ninety eight. However, in the fourth *perek*, the end of *Eli's* life is fast-approaching and now at age ninety eight, it is more plausible that the cataracts in *Eli's* eyes would have progressed and affected both eyes. The gradual loss in vision over the twenty eight year period spanned from the third to the fourth *perek*. This would also explain the reason for the repetition regarding the condition of *Eli's* eyesight. It is therefore plausible to conclude that *Eli* experienced a gradual onset of cataracts common in old age, which began in one eye and progressed to both eyes as he aged. This led to his blindness, explaining his shock and subsequent death upon hearing the news about the *Aron's* capture.

In modern times we can more fully appreciate how lucky we are to be able to successfully reverse the symptoms experienced by our forefathers in the *Tanach*. To remind ourselves of the miracle of vision, every morning we wake up and say *Modeh Ani*; I am thankful. This prayer is recited to remind us not to take our bodily functions for granted. It is only normal to become lax in our appreciation of the way our bodies work, but the stories in the *Tanach* show us that the things we take for granted may not last forever and that we must be thankful for them each day. ■

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PLAGUES 7 TO 10

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Hail, Lightning, and Thunder: The 7th Plague

“*HaShem* said to Moshe, Stretch out your hand toward the sky and there will be hail throughout all Egypt. It will fall on man and animal and on all outdoor plants all over Egypt. Moshe pointed his staff at the sky and *HaShem* caused it to thunder and hail with lightning striking the ground. *HaShem* then made it hail on the land of Egypt. There was hail with lightning flashing among the hailstones. It was extremely heavy, unlike anything Egypt had experienced since it became a nation. Throughout all of Egypt, the hail killed every man and animals in the outdoors. The hail destroyed all the outdoor plants and smashed every tree in the fields. Only in Goshen, where *B’nei Israel* lived, there was no hail” (Shemos 9:22-26).

Any precipitation, let alone hailstones, would be most unusual in Egypt. In most areas, Egypt receives on average 1 inch of precipitation per year, or about 0.1 inches of precipitation (rain, sleet, snow, or hail) per month. No precipitation occurs in July and August; December is the wettest month, when 0.3 inches of precipitation fall in 2 days [1]. According to Rav Samson Raphael Hirsch, this plague was a complete shock to the Egyptians and demonstrated a total revolution in cosmic conditions in Egypt [2].

Lightning, thunder, hail, and rain originate in clouds. Lightning is an electrostatic discharge (or, a spark) which is accompanied by thunder. From the initial discharge of atmospheric electricity, a lightning bolt can travel at speeds approaching 140,000 mph, reaching temperatures of 54,000°F. Lightning rapidly heats the air in its immediate vicinity, causing the heated air to expand and subsequently to produce a supersonic shock wave. This shock wave decays to an acoustic wave that is heard as thunder. As the sound waves propagate along the length of the lightning’s path, sounds originate at varying distances to generate a rumbling or rolling effect. Light travels at 186,282 miles/second and the speed of sound, in dry air, approximates one mile in five seconds. Thus, initially lightning is seen, followed by the sound of thunder. These background facts will be needed later to understand a question presented by the Malbim. Upon seeing lightning one recites the blessing “Who makes the work of creation,” and upon hear-

ing thunder, one recites the blessing, “for His strength and His power fill the universe.” A lightning strike at a very close distance is accompanied by the smell of ozone. Lightning within thunderstorms produces gaseous nitrogen oxides which react with other atmospheric chemicals and, in the presence of sunlight, produce ozone. Ozone, a strong oxidizing agent, if present in significant amounts, is a lung irritant [3]. In this plague, the lightning and thunder caused psychological distress to the Egyptians, whereas ozone, a respiratory irritant, caused physiological pathology.

These hailstones consisted of an intermingling of ice and fire, demonstrating a miracle within a miracle; the water of the ice did not extinguish the fire and the fire did not evaporate the water.

To emphasize that the seventh plague was not a natural phenomenon, but rather was orchestrated by *HaShem*, Moshe drew a line on a wall. He told Pharaoh that the next day, when the sun reached that mark, at that exact time, the plague would start (Rashi, Shemos 9:18). The Malbim, noting a potential scientific problem, concluded that there were two distinct types of hailstones and thunder. Lightning, thunder, and hail all originate within clouds and for these three phenomena to simultaneously commence exactly when Moshe indicated would be a scientific impossibility. Lightning originating in the clouds could appear on Earth at exactly the time indicated by the sun reaching the mark on the wall. However, thunder travels slower and additional time was needed for hail to form in the clouds and to be deposited on Earth. These time delays for the commencement of the plague would be interpreted by the Egyptians as indications that they were natural occurrences, and not a plague directed by *HaShem*. The Malbim therefore suggested that at time zero (i.e., when the sun reached the mark), *HaShem* created special types of thunder and hailstone that traveled exceedingly fast to coincide with the lightning, thereby confirming the time schedule established by Moshe. The Malbim compared the speed of these initial hailstones to bullets

leaving a rifle, thereby explaining their lethality (*i.e.*, “the hail killed every man and animal in the outdoors”). Thereafter, subsequent hailstones and thunder proceeded according the laws of nature.

A variety of opinions describe the nature of the hailstones (Shemos 9:24). Perhaps, the best known is that mentioned by Rashi. These hailstones consisted of an intermingling of ice and fire, demonstrating a miracle within a miracle; the water of the ice did not extinguish the fire and the fire did not evaporate the water. Some hailstones were transparent with the flame flickering within, whereas other hailstones were coated by fire; the hailstones were huge and deadly [4-6]; [Bamidbar Rabbah 12; Malbim]. S’forno suggested that the forceful thrust of the hail carried an enflamed air, perhaps, referring to the generation of an intense heat of friction. Rav Avigdor Miller [7, 8] postulated that the hailstones were actually “hot pellets of solid stone.” Falling from great heights, the red hot stones acquired an accelerated velocity so that each stone became a deadly missile to destroy whatever it struck. Ibn Ezra, as interpreted by Rav Aryeh Kaplan in Me’am Loez [5] and probably based on Berachos 54a, presented a unique approach and suggested that the flaming hailstones may have been part of a meteor shower. Meteor showers consist of a collection of particles, composed of ice and rock, are the remnants of comets that once passed through the inner solar system. The rocks vary in size, from dust to a small boulder. When these meteoroids enter the Earth’s atmosphere, the ensuing friction with the air causes them to heat up and glow. Under normal conditions, most meteoroids burn up completely in the atmosphere but occasionally some persist to hit the Earth [10, 11].

Eventually, Pharaoh breaks under the pressure of the plague and summons Moshe to terminate it. “Pharaoh sent word and summoned Moshe and Aaron. He said to them, “This time I am guilty! *HaShem* is Just! It is I and my people who are in the wrong! Pray to *Hashem*. There has been enough of *HaShem*’s thunder and hail. I will let you leave. You will not be delayed again” (Shemos 9:27-28). Interestingly, Pharaoh’s initial complaint was not to terminate the hail and lightning which were lethal to the people and which devastated the Egyptian economy (*i.e.*, the destruction of cattle and crops), but rather to halt the thunder. Because the lightning strikes came in close succession [12], there was no sound modulation as in normal thunder, rather each clap of thunder exploded with the same deafening noise. The thunder was a plague unto itself, with the extraordinary noises a fearsome experience [7, 8]. Excessive noise adversely affects human physiology and psychology. In response to noise pollution, the levels of adrenaline and cortisol, the so-called stress hormones, are elevated, with a concomitant increase in blood pressure and heart rate and a

decrease in the immune system’s ability to fight infection. People exposed to noise pollution get angry easily, are anxious, more depressed, and are less likely to help others [9]. Rav Miller [7] stated that “the noise of booming thunder and crackling lightning were terrifying, a ringing in the ears beset each person” (*i.e.*, tinnitus).

This plague also destroyed the Egyptian agricultural economy: “The flax and the barley were smashed, for the barley was nearly ripe and the flax was in its stalk. And the wheat and the spelt were not smashed, for they are late in ripening” (Shemos 9:31-32). Both the flax and barley, ready for harvesting, were devastated, whereas the wheat and spelt, immature and thus soft and flexible, were able to withstand the crushing hail (Rashi). As worshippers of the lamb, Egyptians avoided the use of wool, but rather used flax to manufacture linen [7]; Egyptian linen was of particular high quality (Mishlei 7:16). Barley was food for the cattle and horses (Pesachim 3b). The Egyptian economy was, therefore, in ruin. This plague, as described in Tehillim (78:47; 105:32), made note of huge hailstones that destroyed Egyptian grape vines and tress, the fig tree in particular. Hail killed the cattle and fiery bolts of lightning devastated the flocks (Tehillim78:48). The sparing of the wheat and spelt provided some hope of survival to the Egyptian populace. However, these crops would serve as food for the locusts (Plague #8).

In the early19th century, a papyrus, discovered in Egypt, and written by Ipuwer, an Egyptian, apparently was an eye witness account of the ten plagues and the resultant exodus of *B’nei Yisrael* from Egypt. Known as the Admonitions of Ipuwer, portions of the papyrus parallel the events noted in Shemos. Regarding the 7th plague the following are mentioned: (a) “Forsooth, gates, columns, and walls are consumed by fire. The sky is in confusion. It almost destroyed all mankind” (parallel: Shemos 9:23, 24); (b) “lower Egypt weeps. The entire palace is without revenues. To it belong wheat and barley, geese and fish”; (c) “Trees are ruined. No fruits, no vegetables are to be found. Grain has perished everywhere. The land is desolated”; and (d) “Forsooth, that has perished which was yesterday seen. The land is left over to its weariness like the cutting of flax” (parallel *posukim*: Shemos 9: 25, 31, 32) [13, 14].

Locusts: The 8th Plague

“Moshe raised his hand over Egypt and all that day and night, *HaShem* made an east wind blow over the land. When morning came, the east wind was carrying the locusts. The locusts invaded Egypt, settling on all Egyptian territory. It was very severe. Never before had there been such a locust plague and never again would the like be seen. The locusts covered the entire surface of

the land, making the ground black. They ate all the plants on the ground and all the fruit on the trees, whatever had been spared by the hail. Nothing green remained on the trees and plants throughout Egypt” (Shemos 10:13-15).

Locust swarms are relatively common in Africa. Rav Kaplan [11] noted that the east wind often blew across the desert from Arabia carrying locusts. If so, how did Pharaoh distinguish this specific insect invasion which was orchestrated by *HaShem* from that of a natural occurrence? Although locust swarms utilize wind to aid in their flight, mostly they travel and are active during the daytime, with their flight migration beginning in the late morning; usually, locusts do not fly at night [15]. The *pasuk*, however, noted something unusual, in that the wind carried the locusts by day and *also* by night.

The locusts, or *arba* of the 8th plague, were of the species, *Sbistocerca gregaria* (the desert locust) [16, 17]. The desert locust in Africa is a fully gregarious consumer, causing extensive devastation to pasture lands and to crops, and particularly known for its long range of migration. The largest recorded locust swarm is reported to have covered 400 sq mi, comprising approximately 40 billion insects [17]. The locust invasion constituting the 8th plague was particularly severe; “never before had there been such a locust plague and never again would the like be seen.” Yet, another severe locust swarm was noted in Yoel (2:1-11), but in that case, *Eretz Yisrael* was the target of the locust invasion. The locust swarm that invaded Egypt consisted only of one species, the *arba*, whereas the swarm that invaded *Eretz Yisrael* consisted of 4 species of locust, *arba*, *gozzum*, *yellek*, and *chasil* (Rashi in Yoel, 2:2; Shemos 10:14). Yet, in Tehillim (78:46), mention is made of the ten plagues and *chasil*, not *arba*, was noted in the 8th plague. Perhaps, Rashi meant that the swarm in Egypt consisted *predominantly* of one species, the *arba*, with *arba* referring both to a single species of locust as well as to the generic name for locusts (the Hebrew root of *arba* is *rov*, or many) [18]. Ramban (Shemos 10:14), disagreeing with Rashi’s interpretation, postulated that the difference between the locust swarm that invaded Egypt from the swarm that invaded *Eretz Yisrael* was not a function of the type of species of locust. Rather, the swarm that invaded Egypt was unique in that locusts normally descend upon an arid environment, not upon a moist, humid terrain as the basin of the Nile River. As proof, Ramban noted that the four years of the locust plague in Yoel coincided with a severe drought.

In the *pasukim*, both in Shemos and Yoel, mention was made of the accompanying economic destruction caused by the locust invasion. Locusts consume the equivalent of their own weight in a day. The desert locust may eat 1.5 grams of vegetation/day; de-

pending upon the actual number of locusts, a high density swarm covering an area of 1 km² potentially would consume between 0.8 to 10 tons vegetation/day. Most species of locust feed mainly on grasses and cereal crops, such as wheat, but they may also consume grapevines [19]. The ecologic consequences of a locust invasion plague are extremely devastating, as locusts feed not only upon leaves, but also upon flowers, fruits, seeds, tree bark, and shrub bark, and - due to their weight - break the trees upon which they settle *en masse* [17].

Locusts consume the equivalent of their own weight in a day. The desert locust may eat 1.5 grams of vegetation/day; depending upon the actual number of locusts, a high density swarm covering an area of 1 km² potentially would consume between 0.8 to 10 tons vegetation/day.

As with most plagues, the locust invasion brought distinctive psychological distress upon the Egyptians. A locust swarm can be miles wide, blotting out the sun, and is accompanied by an irritating buzzing sound. In addition to chirping, locusts make a humming sound by rubbing their legs and wings against their body. In November 2004, a moderate locust swarm invaded Israel. An eyewitness gave this account: “It’s a little overwhelming when the sky becomes darkened, you hear a big buzz, and all of a sudden, there’s a shadow and you feel like an airplane is flying above you” [20]. In Yoel (2:2), the Malbim and the Radak described the locust swarm as appearing like clouds and thick fog, blocking the sun’s rays and darkening the day. The phrase “sounding like clanging chariots” (Yoel 2:5) characterized the nerve-wrecking, buzzing sound produced by the locust chirping and wing flapping.

“Pharaoh hastily summoned Moshe and Aaron. ‘I have committed a crime,’ he said, ‘both to

G-d, your L-rd, and to you. Now forgive my offense just this one more time. Pray to G-d, your L-rd. Just take this death away from me!’” (Shemos 10:16-17). What was Pharaoh’s rush, if the locusts had already devastated Egypt? Rav Zalman Sorotzkin [21] suggested that Pharaoh was concerned that if the locusts stayed beyond the 3 days of the plague, the female locust would deposit eggs into the soil. Eventually, these eggs would hatch and the offspring would again evoke destruction, albeit, at a later time.

Moshe left Pharaoh’s presence and prayed to *HaShem*. *HaShem* turned the wind around, transforming it into a very strong west

wind. It carried away the locusts and plunged them into the Red Sea. Not a single locust remained within all Egypt's borders" (Shemos 10:18-20). Rav Sorotzkin [21] questioned why a *very strong* wind was needed to carry off the locusts. He suggested that the locusts which invaded Egypt were small and scrawny and, thus, only a wind of moderate strength was required for their flight. However, the locusts that were carried away were fattened, and thus required a *very strong* wind to support this extra weight. Nevo [17] noted that one ton of locusts, consisting of approximately 500,000 locusts and which constitute only a small portion of an average swarm, consume as much food in one day as about 10 elephants, 25 camels, or 2,500 human beings.

A *midrash* described the initial attitude of the Egyptians towards the plague of locusts. "Once the locusts came, the Egyptians rejoiced and said, 'Let us gather them all and fill our barrels with them.' *HaShem* said, 'Wicked people, with the plague that I have brought against you, are you going to rejoice?' Immediately, *HaShem* brought upon them a western wind and none were left. What does it mean that none were left? Even those that were pickled with salt and sitting in their pots were blown away" (Midrash Rabba, Shemos 13:7). Rav Sorotzkin [21] postulated that the *very strong* west wind was needed to smash these canning jars and to carry away the pickled locusts. Although today's Jews may not have a specific craving for locusts, there are kosher species of locusts that, apparently, were eaten by Jews. "Every flying teeming creature that walks on four legs - it is an abomination to you. Only this may be you eat from among all the flying teeming creatures that walk on four legs: one that has jumping legs above its legs, with which to spring upon the earth. You may eat these from among them: the *arba* according to its kind ..." (Yayikra 11:20-22). Although the continuous tradition (*mesorah*) to distinguish kosher from non-kosher locusts has been lost from many Jewish communities, it was maintained by those communities originating from North Africa and Yemen and was subsequently recorded by Dr. Zohar Amar, head of the Department of Land of Israel Studies and Archeology, Bar Ilan University [22].

In November, 2004, a huge swarm of desert locust swept across the Sinai Desert and eventually settled in the Arava plains along the Jordan River. Dr. Zohar and his students traveled to the Arava and captured some *arba*. After removing the walking and jumping legs, wings, and head, the *arba* were fried and eaten. The students observed that fried *arba* tasted similar to French fries. However, Dr. Zohar explained that the taste of *arba* was dependent upon the food they consumed for their last meal [23].

Darkness: The 9th Plague

Only three sentences in the Torah are allotted to the 9th

plague, darkness. "*HaShem* said to Moshe, 'Stretch forth your hand towards the heavens and there will be darkness upon the land of Egypt.' Moshe stretched his hand toward the heavens and there was darkness throughout the land of Egypt for a 3-day period. No man could see his brother nor could anyone rise from his place for a 3-day period; but for all *B'nei Yisrael* there was light in their dwellings" (Shemos 10:21-23).

To enhance the impact of the plague, the darkness commenced at about 9 A.M. after the sun already had arisen. Suddenly, all of Egypt was enveloped by darkness. As the Egyptians worshipped the sun as a god, this plague showed the futility of that belief [5]. According to Rav Miller this plague symbolized the darkness of ignorance in which the Egyptians and the "civilized" world lived. *Chazal* discussed the nature of this darkness, which was not the darkness of a typical night but, rather, it was a *tangible* darkness that could be felt and that did not support combustion, thereby making respiration difficult. Rav Miller suggested that this tangibility was due to heavy soot particulates that blackened the skies and made breathing extremely difficult, causing the death of many Egyptians [8]. The source of these particulates may have been from a volcanic eruption or from a bombardment of meteoric dust [7]. Torah Temimah (10:21) presented a novel approach and suggested that the palpability of the darkness was not due to an atmospheric phenomenon but rather to an ocular pathology, a physical blockage on the cornea, perhaps cataracts. Rav Hirsch [2] explained that the tangibility of darkness referred to the Egyptian reliance on their sense of touch, rather than on their eyesight, to differentiate between objects. Rashi noted that at night, the darkness intensified as compared to its effect during the daylight hours. Accordingly, the alternation of an intensified darkness (*i.e.*, night) with darkness (*i.e.*, day) allowed the Egyptians to calculate the passage of time.

Interestingly, this plague was lethal to those of *B'nei Yisrael* who had neither the intentions nor the desires to leave Egypt, to receive the Torah, and to enter into *Eretz Yisrael*. These Jews died during the plague of darkness. There are various estimates of the number of Jews who died; one thought is that 80% of the Jewish population (Rashi, Shemos 13:18), or 12 million people, died. During the initial three days of this plague the darkness was total in scope, so that the Egyptians were unable to see the Jews burying their dead.

During the next 3 days, the darkness intensified and prevented the Egyptians from movement - those sitting could not stand erect and those standing were unable to sit. Perhaps the Egyptians were paralyzed with fear. Rav Hirsch [2] explained that this plague was the most comprehensive of the plagues, in that

each individual was held or chained to the place he happened to be: fasting, without bathroom facilities, and isolated from others. The 10 plagues are mentioned in Tehillim (Psalm 105), but not in the proper sequence, as their description commences with the 9th plague. To explain this, Rav Feuer [16] noted that this plague was the most far-reaching of all the plagues. The preceding eight plagues affected only limited segments of the Egyptian population, whereas the plague of darkness enveloped each individual and every inch of the Egyptian empire. No one had control over himself or of his possessions, thus demonstrating *HaShem's* complete mastery over man and nature.

It was during this second period of paralyzing darkness that the Jews entered into the Egyptian homes, searching for the locations in which the Egyptians had hidden their valuables. Once located, however, these hidden treasures remained untouched. The lack of theft by *B'nei Yisrael* was most impressive to the Egyptians and earned *B'nei Yisrael* a reputation of honesty [19]. Knowledge of the locations of the treasures later enabled the Jews to request those hidden valuables, without the Egyptians denying their existence. Rav Elie Munk [6] noted that the positive impression of the Jews not stealing the hidden treasures was the factor that, at the time of the Jewish departure from Egypt, convinced the Egyptians to willingly give their treasures to *B'nei Yisrael*. This fulfilled *HaShem's* promise to Avraham, that his descendents would leave Egypt “with many riches” (Bereishis 15:14).

Although *B'nei Yisrael* could have escaped from Egypt during this plague, they did not. The Chasam Sofer explained that the Jews kept the promise of Yosef to Pharaoh, namely that the Jews would not leave Egypt without Pharaoh's permission. He further suggested that this oath of loyalty was required annually of all Pharaoh's servants.

The final portion of the Torah's description of the plague of darkness concludes with, “for all *B'nei Yisrael* there was light in their dwellings.” The commentaries extended this idea to explain that the light was not limited to Jewish dwellings but “traveled” with *B'nei Yisrael* and allowed them to discover the Egyptian hidden valuables (Shemos Rabbah 14:2). This idea was further developed in that the Jews had more illumination than usual, *i.e.*, even at night, there was light [5]. Using the terminology of today, *B'nei Yisrael* experienced night vision, or, the ability to see in low light conditions. An enlarged pupil relative to the rest of the eye is favorable for night vision. Soldiers who are issued night vision glasses are provided with atropine-containing eye drops to dilate their eyes [24]. Although *HaShem* did not distribute night vision glasses to *B'nei Yisrael*, causing dilation of their pupils would enhance vision in low illumination.

Rabbi Mordechai Friedman [25] posed an interesting question - if we assume that the severity of the plagues increased as they approached *makkos bechoros* (killing of the first born), what was so terrible about the plague of darkness? On the contrary, according to the above-cited *midrash*, the Jews, rather than the Egyptians, died during this plague. He presented various explanations and the one of most interest centered on psychological warfare. In the later 3 days of the plague, the Egyptians were in a type of paralyzing confinement, unable to move, eat, use bathroom facilities, or defend themselves. In the absence of the ability to see, their other senses became sharpened and the Egyptians keenly heard the Jews prowling through their homes and clearly heard the sounds of animals and other creatures, yet they were paralyzed. The Egyptians realized that the tide had turned in favor of *B'nei Yisrael*. Rav Eliyashiv (cited by Rav Lebel Katz in *Ohel Aryeh*, vol. 2) noted that now the Egyptians called out for assistance from the Jews (*i.e.*, role reversal, the “masters” were subservient to the slaves).

There may be many similarities between the plague of darkness and military torture techniques used to obtain information from prisoners. In describing the plague of darkness the Midrash Tanchuma (Parshas Bo, 4) noted that the Egyptians felt as if they were imprisoned in jail. And, Egyptian prisons, apparently, were darkened (as noted in Bereishis Midrash Rabba (89), Yosef spent two years in *darkness* in prison). Left in the dark and in solitary confinement results in sensory deprivation; this technique was used in Guantanamo Bay as an interrogation strategy for terrorists. Arabs also utilized this mode of punishment on their captives. Brian Keenan spent four years as a hostage in Lebanon, of which 7 or 8 months were in darkness. “The nothingness, that was extremely hard. Because the question in your head is how long am I going to get through the next ten minutes? Or, months later, how am I going to get through the next day? Is there enough left in my head?” He continued, “I remember one occasion waking up and having to squeeze my face and my chest and thinking to myself, ‘Am I still alive?’” Hallucinations are common to those in solitary confinement and in the dark. As noted by psychologist Dr. Robbins, “In the dark room there is nothing to focus on. In the absence of information the human brain carries on working and processing information, even if there is no information to process and after a while it starts to create that information itself.” In a 48-hour experiment in which volunteers agreed to be shut inside a cell in a nuclear bunker, hallucinations were common and included seeing mosquitoes and fighter planes buzzing in the head, seeing little cars, snakes, and zebras, and visualizing a pile of thousands of oyster shells [26].

The 9th plague was noted in the Ipuwer Papyrus [13] and in the apocryphal book, The Wisdom of Solomon [27], in which many more sentences are devoted to this plague than the three sentences in *Shemos*. Below are some passages from the Wisdom of Solomon:

For when lawless people thought to oppress a holy people, they, prisoners of darkness and captives of a long night, lay imprisoned under their roofs, fugitives from the eternal providence.

For when they thought to escape from their secret sins under a dark veil of forgetfulness, they were scattered, being terribly astonished and terrified by phantoms.

For the cranny that held them did not protect them from fear, but terrifying noises rang out around them, and gloomy phantoms with grim faces appeared.

And no force of fire was able to light, nor did the brilliant flames of the stars avail to illuminate that horrible night.

But there appeared upon them only a self-kindled flame full of fear, but, terrified when the sight was no longer visible, they supposed worse those they saw.

The Wisdom of Solomon continues, with many of the descriptions paralleling the experiences of the volunteers who participated in the above-noted 48-hour experiment of solitary confinement.

Death of the First Born: The 10th Plague

Hashem's total involvement in orchestrating the simultaneous death of all the firstborn is succinctly stated (Shemos 12:12). “And I will pass through the land of Egypt on this night” - I and

not a ministering angel; “and I will strike every firstborn in the land of Egypt, from man to animal” - I and not a fiery angel; “and against all the gods of Egypt I will execute judgments” - I and not a messenger; “I, *Hashem*” - I and no other (Passover Haggadah). As such, there is little else to add, as this specific plague was executed by *Hashem* alone, without employing the various biological, chemical, and physical forces of nature, which, for the other plagues, functioned as His avenging army.

When this plague was related to Pharaoh, Moshe's wording was: “So said *Hashem*, ‘At approximately midnight I shall go in the midst of Egypt. Every firstborn in the land of Egypt shall die, from the firstborn of Pharaoh who sits on his throne to the firstborn of the slavewoman who is behind the millstone and all the firstborn of the animal’” (Shemos 11: 4,5). Rashi noted that the phrase “approximately midnight” was used rather than “at midnight,” as should the Egyptian astrologers err in calculating midnight, they would then accuse Moshe of lying as the plague did not commence exactly at the time foretold by Moshe. Another thought is the phrase “approximately midnight” took into account the different geographically regions in Egypt. Being a rather large country, the exact point of midnight in one region of Egypt slightly differed from that in a more distant region, Later in the *parsha* this plague is restated as a declarative statement, “It was at midnight and *Hashem* struck every firstborn in the land of Egypt, from the firstborn of Pharaoh sitting on this throne to the firstborn of the captive who was in the dungeon, and every firstborn animal” (Shemos 12:29). ■

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