Derech HaTeva

A Journal of Torah and Science

A publication of Stern College for Women,

Yeshiva University

Volume 9 ■ 2004-2005 ■ 5765

Derech HaTeva

Staff

Editors-in-chief

Malkie Krupka ■ **Eliza Moskowitz** ■ **Helen A. Nissim**

■ ■ ■

Cover Design

Shani Guttenberg

■ ■ ■

Layout and Printing

Tova Press, Inc. ■ 718 438.8877

Dedication

This volume of Derech HaTeva is dedicated in loving memory to **Mrs. Esther Rivka Kermaier ע"ה**, mother of Dean Karen Bacon. Esther Kermaier was a woman of valor, possessing both inner strength and exceptional drive. In addition to unbound dedication to her family, she was at the forefront in the development and support of Jewish education in Los Angeles, where her family lived for twenty years. With her husband, **Moshe Aharon Kermaier ע"ה**, she made aliyah and lived in Jerusalem for thirty years. In Israel, she continued her life of chesed and service to the Jewish community. Esther Rivka Kermaier personified and exemplified true Torah values; she earned the love, admiration, and respect of all who knew her.

She will be sorely missed.

Acknowledgements

We would like to extend our gratitude to the Office of the Dean, the Office of Admissions, the Ivan Tillem fund at Stern College for Women, Stern College for Women Student Council, and the Torah Activities Council at Stern College for Women.

We would like to thank Dr. Harvey Babich for his time, patience, and enthusiasm that helped to make this journal a success.

Pasuk

ברוך אתה ה' אלקינו מלך
העולם שלא חסר בעולמו
דבר וברא בו בריות טובות
ואילנות טובים להנות בהם בני אדם.

Blessed are you Hashem, our G-d, King of the universe, who left nothing lacking from His world, and created in it magnificent creatures and beautiful trees, for man to take pleasure in them.

Table of Contents

The Fall of A Giant: A Medical Analysis of Goliath's Demise

Rachel Berley

While the giant warrior Goliath threatens the entire nation of Israel, King Saul searches for a courageous man to fill the heroic void. In his most arrogant way, Goliath shouts forth a challenge: "Choose yourselves a man and let him come down to me" (I Samuel 17:8). David, the future king, volunteers. Refusing to wear a sword or armor, he carries only a staff and a concealed (*Metzudat David*, I Samuel 17:40) slingshot with five smooth stones. In one fluid motion, David flings a stone that hits the giant in the head. And "thus David overpowered the Philistine with the slingshot and stone, he smote the Philistine and killed him" (I Samuel 17:50). As a piece of Jewish history, many people have told and retold this glorious story of the underdog finally being victorious over the literal giant of an enemy. With our ever-developing knowledge of science, though, we may take a deeper look into this at-first-glance folktale and truly understand the episode.

An analysis of the *pesukim* reveal that it was more than just David's ability to handle a slingshot that enabled him to defeat the heavy-favorite Goliath in this epic dual. On account of his medical condition and its dramatic side effects, Goliath was susceptible to a certain strategically maneuvered attack. David used the knowledge of Goliath's pathologies to his advantage to such a degree that the Philistine was struck down in mere moments. It is hypothesized that Goliath suffered from multiple endocrine neoplasia type I and acromegaly [1]. Specific *pesukim* substantiate this claim, once again harmoniously bringing the worlds of Torah and science together.

Goliath's gigantism is expounded upon explicitly in the text of the *Tanach*. The verse states: "A champion went forth from the Philistine camps, whose name was Goliath of Gath; his height six cubits and one span" (I Samuel 17:4). Rav Dovid Qimchi explains that a cubit is roughly equal to two feet and a span is half a cubit, therefore Goliath's total height equaled to about thirteen feet (I Samuel 17:4). Goliath's extraordinary strength also lends proof to his abnormal stature. It states in the *pesukim* that, "He had a copper helmet on his head, and was wearing armor mail; the weight of his armor was five thousand copper shekels. He had a copper shield on his legs and a copper neck guard between his shoulders. The shaft of his spear was like a weavers' beam and the blade of his spear weighed six hundred iron shekels" (I Samuel 17:6,7). The *Chazon Ish* interprets the weight of a silver shekel to equal eight-tenths of an ounce, which makes Goliath's armor weigh two hundred and fifty pounds and his spear thirty pounds (I Samuel 17:4). The text of the Tanach indicates that Goliath would have been over nine feet tall and had the strength to wear a coat of chain mail with a weight of one hundred and twenty pounds. The tallest person to be recorded in the twentieth-century in the United States was eight feet eleven inches [2].

> From these verses in *Tanach*, it becomes evident that Goliath suffered from weakened vision, possibly caused by a benign tumor of the pituitary gland, known as an adenoma, which could initiate excess production of growth hormone.

The description of Goliath's overwhelming physical stature and strength calls for a further look into his biological makeup. As Goliath's brothers were also giants (*Rashi* & *Maharsha*, Sota 42b), perhaps he suffered from a genetic disorder. Acromelagy is an overproduction of growth hormone by the pituitary gland. This hormone regulates the physical growth of the body. The secretion of growth hormone into the blood stream by the pituitary gland causes the production of another hormone, insulin-like growth factor 1, in

the liver, which upon secretion induces growth of bones and other tissues in the body. If the pituitary gland continues to secrete growth hormone, the level of insulin-like growth factor 1 will rise and eventually lead to excessive bone growth and organ enlargements [3].

A deeper understanding of the working of the pituitary gland will shed much needed light on this issue. The pituitary gland, also known as the master gland because it is the endocrinological center of the body, is a small organ located behind the bridge of the nose and is most important in the regulation of growth, milk production, and in the control of several other endocrine glands. Over- or under-secretions of the pituitary gland can disturb the body's intricate hormonal balance so severely as to cause mental and physical illnesses. Sometimes the anterior lobe or the entire pituitary gland may be enlarged, increasing the production of hormones above their normal ranges. For example, hypersecretion of growth hormone can cause excessive growth. In adulthood, once the bones have stopped growing, an overactive pituitary gland may stimulate excessive bodily growth, resulting in the condition known as acromegaly [4].

Further symptoms of the disease are evident in the case of Goliath within the text of *Tanach*. As David goes out to meet Goliath for battle, the verse states: "He took his staff in his hand and picked out five smooth stones from the brook and put them in his shepherd's bag and in the knapsack, and his slingshot was in his hand" (1 Samuel 17:40). In his tactical approach, David chooses to arm himself with a *single* wooden staff and a slingshot that is hidden away (*Metzudat David*, I Samuel 17:40). Despite David's choice of limited weaponry, Goliath's response to his advancing adversary suggests that he suffers from some form of impaired vision. "The Philistine said to David, 'Am I a dog that you come after me with *sticks*?'" (1 Samuel 17:43). Further in the altercation, David is able to unnoticeably slip into a threatening position by hurrying to close the gap between himself and Goliath. "It happened that when the Philistine arose and moved closer toward David that David hurried and ran to the line, toward the Philistine" (1 Samuel 17:48).

From these verses in *Tanach*, it becomes evident that Goliath suffered from weakened vision, possibly caused by a benign tumor of the pituitary gland, known as an adenoma, which could initiate excess production of growth hormone. Furthermore, as the tumor expands, it compresses the surrounding brain tissue, including the optic chiasm, and produces bitemporal hemianopsia, resulting in headaches and visual field deficits or double vision [5].

With a quick strike, David "took a stone...and slung it and struck the Philistine in the forehead. The stone penetrated his forehead, and he fell upon his face, upon the ground" (1 Samuel 17:49). David's ability to easily pierce Goliath's forehead with his "smooth stones" can be attributed to one of the many symptoms of acromegaly. Upon suffering from acromegaly, the individual's bone structure gradually changes, resulting in altered facial features. One such defect is a thinned frontal bone, which results from an enlargement of the paranasal sinus. This, in turn, allows David's stone to easily penetrate Goliath's skull and become embedded within his enlarged pituitary gland. Severe damage to the pituitary gland may have caused hemorrhaging, resulting in transtentorial herniation and eventual death [6].

This epic battle and eventual demise of Goliath contains many scientific details only realized with the advent of modern science. His intricate medical conditional sheds light on this great Biblical figure and explains how David comes into his own as the hero of the Jewish people.

Rachel Berley is a junior majoring in Biology

Acknowledgements

My endless gratitude is extended to my parents for giving me the opportunity to further my education at Stern College. I would also like to thank my chattan, Akiva Wolk, for helping me with the Torah content and editing. Finally, great thanks to Dr. Babich for his guidance in writing this article.

References

[1] Rabin, D. and P. Rabin (1983) David, Goliath, and Smiley's People. NEJM 309:902.
[2] Hoerth, A. (1998) Archaeology and the Old Testament. Baker Books. pp. 255
[3] National Institute of Diabetes and Digestive and Kidney Disease. www.niddk.nih.gov/health/endo/pubs/acro/acro.htm (Retrieved November 7, 2004.
[4] Van Nostrand's Scientific Encyclopedia, 5th Edition (1976). Considine, D. (Ed.). Van Nostrands Reinhold Co., New York. pp. 1785-1787.
[5] Berginer, V.M. (2000) Neurological aspects of the David-Goliath battle: Restriction in the giant's visual field. Isr. Med. Assoc. J. 2:725-727.
[6] Sprecher, S. (1990) David and Goliath. Radiology 176: 228.

Infertility and Jewish Law

Frida Fridman

In Judaism, marriage and family life are extremely important. In a successful marriage a couple provides each other with support, companionship, and affection. This social aspect of marriage is of great value, but the main reason for matrimony is the creation of a family. The very first Biblical commandment, "Be fruitful and multiply" coupled with "Fill the earth and subdue it" (Genesis 1:28), emphasizes the importance of procreation for the Jewish people; the fulfillment of all the other commandments is dependent on it. The Bible considers children as the very source of blessing in the home. "A man should wish for and desire offspring, beseeching G-d to grant him a household of sons and daughters. He should then guide and raise them to serve G-d" (Sefer Hakedushah).

Unfortunately some couples have great difficulties starting a family, due to a number of medical conditions affecting the reproductive system of either partner. These couples require medical intervention and assistance. In Judaism one of the basic principles is that man should have control over nature. Thus, technological advances in the field of reproductive medicine are generally accepted by Jewish law. Rabbi Akiva suggests that man must play an active role in helping to change the fate of the challenged [1]. Infertility is a challenge that may and should be overcome if desired with the help of science. However, only a well-informed and capable rabbi has the authority to advice the couple on a clinical procedure of such importance [2]. Options for an infertile couple include intrauterine insemination (IUI), in vitro fertilization (IVF), gamete intrafallopian transfer (GIFT), zygote intrafallopian transfer (ZIFT), intercytoplasmic sperm injection (ICSI), sperm donation, surrogacy and adoption. Although all these suggestions are viable, each one has its complications.

IUI combined with hormone treatment to boost egg production, can help couples with low sperm count, mild endometriosis, or cervical mucus problems. During this procedure semen is collected and is placed directly into the uterus, bypassing the vagina and cervix. IVF may help couples with pelvic or tubal damage or male infertility. It involves ovarian stimulation, monitoring, and egg retrieval, followed by sperm processing and fertilization in the laboratory. The fertilized egg is then inserted into the woman's body [3].

GIFT may help people with mild endometriosis, low sperm count, or sperm antibody problems. GIFT is similar to IVF, except the collected eggs and sperm are placed next to each other in a women's fallopian tube, where fertilization normally occurs. ZIFT is a variation of traditional IVF. With ZIFT, the fertilized egg is transferred to the fallopian tube after dividing only to the 2-cell stage, instead of the 4 or 8-cell stage, as with conventional IVF. From the fallopian tube one or more zygotes travel to the uterus for implantation and subsequent development. ICSI was developed to treat couples who previously had a very poor probability of achieving fertilization, due to the male extremely low number of viable sperm. During the procedure, each collected egg is injected, by hand with one of the collected sperm; the fertilized egg is inserted into the woman's body. This treatment gives the couple a higher chance of conception. ICSI has revolutionized treatment for severe male factor infertility because the procedure requires only one healthy sperm to potentially achieve fertilization [3].

Most religious authorities agree that the obligation to procreate can outweigh the necessity to maintain natural procedures, and thus assisted reproductive technology (ART) is very commonly permitted when using the husband's semen. These authorities also agree that procurement of sperm is not considered 'wasting of seed' since the procedure is used to overcome the existing problem of infertility [4]. To insure that a couple receives only the sperm of the husband, infertility clinics must provide especially stringent standards of supervision [1]. The sperm donor is considered the father and the child's status as a Kohen, Levi, or Yisrael is determined according to the father's lineage, even without the act of intimacy [2].

The Talmud mentions only three partners in creation; the husband, the wife, and G-d. Thus, most rabbis condemn artificial fertilization by a donor other

than the husband, as in violation of family integrity, even if the "charge" of adultery cannot be sustained. Ramban in his commentary on, "And unto the wife of your fellow you shall not give your semen for seed to defile her through it" (Leviticus 18:20), explains that adultery is forbidden since the semen deposited by a stranger would render the paternity of a child questionable and is thus regarded as quasi-adulterous in nature and in violation with the spirit of the law [5]. But there are some rabbis who are willing to consider, on a case-by-case basis, this procedure for those couples who cannot be reconciled either to a childless marriage or to adoption. In such cases, sperm from a non-Jewish donor is preferable since the danger of incest within the community would be removed [6].

In the cases of ovum donation, surrogacy and adoption, any confusion regarding the status of a child born under such circumstances can be settled by religious conversion, which severs any ties to the biological parents, even to the Jewish biological father [6]. In the case of egg donation, Rabbi Aharon Soloveichik suggests that since during the first forty days of conception the fertilized egg is considered just a corpus of water, the fertilized egg is not viewed as an entity of any material substance prior to forty days. Therefore, a child born from a Jewish mother with an implanted egg donated by a Gentile woman requires no conversion. This validates the notion that maternity is defined by the birth woman, not by the egg donor [1].

In a case where the use of a particular reproductive technology has been decided upon with the guidance of a knowledgeable rabbi, the couple may need to address the issue of multifetal pregnancy reduction and disposal of untransplanted embryos. In regard to these issues, recent rabbinical rulings show a greater similarity to the views adopted by the Ethics Committee of the American Fertility Society than to the Instruction of the Roman Catholic Church. Jewish law maintains that eggs fertilized in vitro and have not been transplanted, have no standing and may be discarded. This ruling may have its basis on the Talmudic statement that an embryo is "mere water" during the first forty days of conception. It has also been deduced that embryos may be examined for the purpose of sex selection against sex-linked diseased and for screening of genetic defects. However, IVF solely for the purpose of genetic screening rather than for overcoming a fertility problem requires further investigation [7].

Multifetal pregnancy reduction, when performed to ensure that the remaining fetuses would be born healthy and that the mother is unharmed, is a morally acceptable procedure. The determination of the number of fetuses to be reduced is a medical decision, rather than a halakhic issue. However, no religious authority would permit multifetal pregnancy reduction for convenience or choice, such as reducing twins to singletons. Great care must be taken to sacrifice the minimum number of fetuses that will reasonably assure the remaining fetuses and the mother are at no risk [7].

All the four Biblical matriarchs; Sarah, Rebecca, Rachel and Leah, suffered from either primary or secondary infertility. Rebecca was cured through Divine intervention. The other three women resorted to adoption. They offered their maidservants as concubines to their husbands, so that they would be able to adopt their husbands' offspring as their own. In the commentary on, "And Abraham hearkened to the voice of Sarah" (Genesis 16:2), Ramban explains that Abraham did not intend to procreate through Hagar, but did so with a sole intention that his wife, Sarah, fulfill her desire and derive joy from the children of her maidservant [5]. Rashi proposes that the matriarchs expected to bear their own children as a Divine reward for giving their husbands children in any manner they could. Some believe that adoption may promote conception in infertile women, although scientific proof of this concept is lacking [8].

There is no doubt that lack of children leaves a painful void. Human paternal and maternal inclinations are deeply ingrained and cry out for expression. Our matriarch Rachel cried out to G-d in agony, "Give me children, or else I will die" (Genesis 30:1). Infertility is a great challenge but as our Sages teach us, "G-d does not come to His creations with overburdening demands" (Avodah Zarah 3a). Whenever G-d presents man with a challenge, He provides him with the inner strength and technology to overcome it [9].

Frida Fridman is a junior majoring in Biology.

Acknowledgements

I would like to express my sincere gratitude to my wonderful parents who support me always, to Dr. Babich for his guidance and encouragement, and to Mrs. Shulman for her help in reviewing the article.

References

[1] Brander, K. (2001) Artificial Insemination and Surrogate Motherhood through the Prism of Jewish Law. B'Or Ha'Torah 12:59-65.

[2] Hirsh, A.V. (1998) Infertility in Jewish Couples, Biblical and Rabbinical law. Hum. Fertil.1:14-19.
[3] Paris, A. ART:ZIFT, GIFT, ICSI. https://rail.adm.yu.edu/pls/yuprod/bwskotrn.P_ViewTran (retrieved January 12, 2005)
[4] Grazi, R.V. and, Wolowelsky, J.B. (1993). Homologous Artificial Insemination (AIH) and Gamete Intrafallopian Transfer (GIFT) in Roman Catholicism and Halakhic Judaism. Int., J. Fertil.38:73-78.
[5] Rabbinical Council of America. (1998). Survey of Recent Halakhic Periodical Literature: Surrogate Motherhood. Tradition 32:146-167.
[6] Grazi, R.V., Wolowelsky, J.B., and Jewelewicz, R. (1994) Assisted Reproduction in Contemporary Jewish Law and Ethics. Gynecol Obstet Invest. 37:217-225.
[7] Grazi, R.V. and Wolowelsky, J.B. (1991) Multifetal Pregnancy Reduction and Disposal of Untransplanted Embryos in Contemporary Jewish Law and Ethics. Am. J. Obstet. Gynecol. 165:1268-1271.
[8] Blondheim, S. H. and Blondheim, D. E. (1985) Matriarchal Infertility and Adoption as a Prelude to Conception. Koroth. 9:1-5.
[9] Abramov, T. (1988). The Secret of Jewish Femininity, Insights into the Practice of Taharat HaMishpachah. Feldheim/Targum, NY, NY (see pp165-166).

Oral Ailments –New or Old?

Ronit Gold

The Talmud is mentioned by historians as a source of information about medicine and science [1]. Selections from the Talmud are important for us today, since they give insight into dental problems which affected people almost two thousand years ago. Are today's dental remedies and ailments new, or are they based on remedies cited centuries ago in the Talmud?

The phrase, re'ach hapeh, refers to an offensive odor emitted from the mouth. The Talmud describes the giant Goliath as having a bad odor emitting from his mouth (Song of Songs Rabbah 4 fol 24 d). The same malodor was evident in an adulteress (Numbers Rabbah 9:21). Re'ach hapeh was viewed as a physical defect and as a serious disability, particularly regarding spouses and priests (Ketubot 72ba, 75a). Therefore, if one who married a woman on the condition that she was free of any physical blemish and later discovered she had re'ach hapeh, that marriage was considered invalid. Bad breath also prohibited kohanim, the priests, from performing their holy duties in the Beit Hamikdash. One treatment for priestly bad breath was for the priest to place pepper in his mouth, as apparently it functioned as a deodorizer, thereby enabling him to continue his duties. According to Rashi, this treatment was not mentioned for a wife, since as the husband constantly spoke with her, this treatment was ineffective. According to Rabbi Yochanan, lengthy fasting and daily consumption of lentils can produce re'ach hapeh (Avoth de Rabbi Nathan 6:3; Genesis Rabbah 42:1.) In Berachot (44b) Rabbi Yitzchak stated that one should not converse with people who eat raw vegetables before the fourth hour of the day, because they emit a bad odor from their mouth. One advisable cure was to walk about four 'ells' (about, forty five inches) after eating and before lying down to sleep, so as to avoid food putrefaction, the cause of re'ach hapeh (Shabbat 41a). A Tosefta in Ketubot (5:4) mentioned that a man can not force his wife to spin flax because this work causes eczema on the lips and causes the mouth to emit a foul odor. However, this applied only to spinning Roman flax (Ketubot 61b), but not to the spinning of wool (Ketubot 5:5).

Bad breath has an impact on the marital obligation of a dead husband's brother to the childless widow (yibum). According to Jewish law, if a man dies without children his widow is obligated to marry the husband's brother (Deuteronomy 25:5-10). Under certain circumstances the widow may be exempt (chalitza) from marrying her brother-in-law. If the two brothers had oral or nasal malodor, the wife can claim that although she tolerated the foul odor of her late husband, the odor of her brother-in-law was unacceptable and therefore she was exempt from yibum (Ketubot 75a, 72b).

The Mishna in Shabbat (6:5) referred to pain originating in the teeth. "A woman may go out from a private domain into a public domain on Shabbos with...a peppercorn (black pepper), globule, and anything in her mouth." The Rambam, in his commentary on the Mishna, explained that a woman may put salt in her mouth or anything similar, if her mouth has some contamination or bad breath. Rav Ovadia of Bartenura specified that the peppercorn was to counteract bad breath and a grain of salt to cure a disease of the teeth. The Mishna related that in order to improve the odor from one's mouth, one should place a pepper in the mouth or chew the gum, mastic (Shabbat 9:6, 6:5, fol 90a and fol 65a). In a Tosefta in Shabbat 8:7, it is stated: "It is forbidden to chew mastic on Shabbos, yet it is permitted for the prevention of oral malodor." Rubbing one's teeth with dry tooth powder, sam yavesh, also improves mouth odor. Moreover, ginger (zangvil) and cinnamon (dartzona) were placed in the mouth and used by women to make their breath more pleasant (Shabbat 65a).

Today we know that the cause bad breath is bacterial putrefaction of foods within the oral cavity. In the initial phase of food decomposition, glycoproteins are deglycosylated by Gram positive bacteria, exposing the proteins to proteolytic enzymes secreted by Gram

negative bacteria. The proteins are hydrolyzed to amino acids, which can be broken down further to the malodorous end products [2]. Antibacterial mouthwashes are used to treat bad breath, as they kill the anaerobic bacteria causing the mouth odor. Breath mints, lozenges, drops, sprays, and chewing gums, stimulate the flow of saliva in a person's mouth. Saliva cleanses the mouth and removes particles that may cause odor [3]. In the times of the Talmud, the chemical reactions caused by chewing gum, placing pepper, or using ginger and cinnamon were known as methods to improve bad breath. Through the years, technology has improved these methods. Nowadays, it is more common to use mouthwash than powders, but both have the same effect.

In the times of the Talmud, the chemical reactions caused by chewing gum, placing pepper, or using ginger and cinnamon were known as methods to improve bad breath.

The Talmud discusses another illness of the mouth named chinke, which refers to an ailment of the gums (Gittin 69a). Chinke probably is derived from the Hebrew word, chanichaiim, meaning gums. Rabbi Yochanan recommends placing chamti, which is pyrethrum and mamru, to overcome this illness. Chamti is derived from the Hebrew word cham, meaning hot or strong, and mamru, from the Hebrew word mar, meaning bitter, since this combination was a bitter spice. Chinke may refer to an abscess in the oral cavity, although it is uncertain whether it is an abscess of the tonsils, soft palate, or the gums (Gittin 69a). In modern dentistry we learn of two origins for an abscess. The first originates from a serious infection that can develop in the tissue around the tooth. Bacteria spread from the root of the tooth to the tissue underneath, creating a pus-filled packet called an abscess. An abscess may also develop because of a gum disease, gingivitis or periodontitis [4]. The Talmud is of the opinion that an abscess is a disease of the gums.

Tzafdina (or, stomatitis) is another illness mentioned in the Talmud, which affects the gums and is indicated by the emission of blood from the gums when placing anything on the molar teeth (Yoma 84a). A modern translation of the Talmud identifies a similar disease to tzafdinah known as scurvy [5]. Scurvy is a pathology marked by spongy gums and the loosening of the teeth and is caused by a deficiency in vitamin C [6]. Rashi is of the opinion that tzafdina is a disease of the teeth and identifies it as misgue (Abodah Zarah 28a; Baba Metzia 85a). This disease can be dangerous, since it begins in the mouth and spreads to the intestines. The cause of this malady is the eating very cold wheat foods, very hot barley pap, or remnants of fish stew and flour. In recent studies, stomatitis has been defined as a chronic debilitating bacterial infection with inflammation of the oral tissues, usually beginning in the periodontium, the soft tissue surrounding the teeth or facial area. It appears that this disease is a progressive oral bacterial infection, leading to a prevalence of Gram negative anaerobic bacteria [6]. These studies concur with the ailment as scurvy of the gingiva, characterized by spongy gums and loosening of the teeth.

Rabbi Yochanan suffered from tzafdinah and was cured by a Roman woman. She treated him on a Thursday and a Friday, but he declined the third treatment as it occurred on the shabbos. The Roman woman told the secret of her herbal treatment only on condition that Rabbi Yochanan would not reveal it. Although she divulged it to him, the next day he referred to it in his public lecture. As a result, she hung herself. The Talmud debates the exact nature of her remedy. The main ingredients included leavening water (water left after the kneading of dough), olive oil, salt, and goose fat, to be applied with a goose feather. Rav Abaye tried the remedy but was unsuccessful in curing his ailment. However, an Arab recommended using the stones of unripe olives, burning them in a new shovel, and sprinkling them on the gums; this concoction cured the illness.

In Shabbat (111a) it is stated, "He whose teeth ache should not sip vinegar and spit it out, but may sip as usual and if it cures, it cures." The Talmudic discussion concludes that vinegar, made of ripe grapes, was helpful in healing certain diseases of the gum. Vinegar made of unripe grapes was harmful to the teeth, kachometz lashinayim (Mishlai 10, 26). Rashi clarified that vinegar was helpful for gum recessions, but was harmful for makah bapeh, a sore in the mouth, and instead suggested its use as an analgesic.

Shlomo Hamelech, the wisest of all men, said: "There is nothing new under the sun" (Kohelet 1:9). Most of the oral ailments that are known today were already known in the times of the Talmud. Then, they were treated homeopathically; using herbs and spices [7]. Nowadays, we go to dentists for treatments. Although technology has improved these treatments, the ailments remain ailments and a pain remains a pain. ■

Ronit Gold is a junior majoring in Biology.

Acknowledgements

I am very grateful to my parents for their wholehearted support and guidance. I would also like to thank Dr. Babich for encouraging me to write this article and reviewing it; his constant guidance and support are greatly appreciated.

References:

[1] Tal, M. and Stern N. (1976) References to dentistry in the Bible and Talmud. Isr. J. Dent. Med. 25:E11-E14.
[2] Shifman A., Orenbuch S., and M. Rosenberg (2002) Bad breath - a major disability according to the Talmud. Israel Med. Assoc. J. 4:843-845.
[3] American Dental Association. http://www.ada.org (retrieved July 20, 2004)
[4] http://www.webmd.com (retrieved July 20, 2004)
[5]"Tzafdianh." In A Dictionary of the Targumim, the Talmud Babli and Yerushalmi and the Midrachic Literature. 1971.
[6] MSN Encarta. Online Encyclopedia. http://encarta.msn.com/encyclopedia_761572344.scurvy.html
[7] Blustein, A.M. (1976) A dental debate from the Talmud. Bull. Hist. Dent. 24:110-112

An Ethical Debate: Should Scientists Use Data from Nazi Experiments?

Ariella Goldstein

Though the Nazi death camps are reviled primarily for the mass murder committed there, it is important to note that Holocaust victims were subjected to cruel experimentation as well. From both military and sadistic motivations, a select group of German doctors and scientists conducted brutal experiments on many inmates of the camps. These experiments include, for example, tests of techniques for rewarming victims of hypothermia; victims of these experiments "were immersed into tanks of ice water for hours at a time, often shivering to death, to discover how long German pilots downed by enemy fire could survive the frozen waters of the North Sea" [1]. The Nazi experiments often resulted in the death of the subjects, and obviously involved the torture of the unwilling victims. The clear violation of human rights that these Holocaust victims suffered leaves contemporary researchers with an ethical dilemma: should the data recorded from Nazi experiments be used? Would the use of Nazi data, as some suggest, constitute a callous betrayal of Holocaust victims?

Many scientists dismiss this question as moot; they argue that the data gathered by the Nazis are of no scientific value and for this reason cannot be used. These scientists point out, for instance, that the malnourished camp inmates are not representative of the typical person exposed to freezing water and therefore data on the length of time Holocaust victims were able to survive in frigid waters are useless [2]. However, some researchers, such as Dr. Robert Pozos and Dr. John Hayward, assert that Nazi data, though obtained through immoral means, are not only scientifically valid but crucial to current life-saving research [1]. Pozos claims that Nazi data would benefit his research, which is used in hospitals to rewarm victims of hypothermia. Likewise, Hayward states that Nazi data would benefit his studies that are applied in the rescue of fishermen whose boats have capsized into freezing waters [1]. Pozos and Hayward thus not only argue for the validity of Nazi data but also for their usefulness. It is this alleged usefulness which is at the center of the ethical debate about using Nazi data—arguments supporting the use of the data are predicated upon the assumption that the data are valid and will therefore be useful in life-saving research. Indeed, Kristine Moe suggests that Nazi data which are used "must be reliable... [and] capable of contribution to the greater good" [3]. The question still remains, though, whether or not the life-saving potential of Nazi data justifies their use. A comparison of both secular and halakhic arguments for and against the use of such data can perhaps illuminate this moral challenge.

The first argument often proposed in support of the use of Nazi data is that if the data would help save lives, then at least some good could come out of the horrors of the Holocaust. Alan Rosenbaum explains that "the assumptive moral reasoning in this argument is that there is both good and evil in the Holocaust and in the Nazi medical experiments" [4]. Those who advocate this line of reasoning, then, suggest that the use of Nazi data would, to some degree, mitigate Hitler's crimes.

Another argument offered in defense of the use of Nazi data has a definite utilitarian strain. Utilitarians would choose one action over another if that action will lead to the greater good for the greatest amount of people; in essence, they determine the morality of an action based on whether or not the positive results of that action outweigh the negative results of the action. Following this idea, some ethicists suggest that Nazi data should be used because the good which would result from their use, namely, the saving of lives, would outweigh the negative results, as the victims of the experiments are no longer alive to be harmed [4].

This reasoning is often preferred to the first because it does not ascribe a positive aspect to the Holocaust but merely asserts that lives can be saved through the use of Nazi data, despite their regrettable origin [4]. However, the utilitarian argument, some ethicists assert, is flawed—the benefits of using the data do not so easily outweigh the negative results of this action. Perhaps, the use of the data, as some theorists argue, could constitute a dangerous desensitization of our

morality, as scientists would be dispassionately utilizing data culled from a horrific violation of human rights. Such a desensitization, according to these theorists, might be so damaging that it cannot be outweighed by the benefits that Nazi data would bring to current and future research. Rosenbaum suggests that "if using Nazi data violates a very basic moral principle (e.g., by respecting basic rights) even if future generations benefit in a limited way from their usefulness, then using the data may result in demoralizing our 'moral climate of opinion'... [and] morality itself [is] vitiated" [4]. This line of reasoning would conclude with a ban on the use of Nazi data in order to protect our morality, which is a goal that may supersede the benefits to research that Nazi data might bring.

Furthermore, Rosenbaum warns that the moral degradation from using Nazi data could result in future replications of the Nazi experiments [4]. In essence, if the scientific world recognizes Nazi data, other researchers may not sense the immorality of the Nazi experiments. This reasoning fits into another utilitarian argument against the use of Nazi data, namely, that the refusal to use the data or to acknowledge the experiments would serve as a deterrent to future unethical scientists possibly contemplating immoral experimentation. Arthur Schafer suggests that if Nazi data are "pronounce[d] an anathema... the conscience of... the research community... will feel a strong disinclination to participate in such research" [5]. This argument offers a compelling reason to refrain from using Nazi data: the protection of future participants in scientific experiments, a benefit which surely outweighs the usefulness of Nazi data.

In recognition both of the significant goal of preventing further immoral experimentation and the usefulness of Nazi data, compromises of the two positions have been proposed. One such compromise is that Nazi data could be used without citation of the scientists. However, the notion of deterrence through non-citation, one can argue, is an illusion. After all, the Nazi experiments were so appalling that "citation of data yielded by those studies will not serve as an impetus for the repetition of those horrendous practices. Nor is refusal to cite those results likely to serve as a deterrent to a diabolically inclined madman" [6]. Anyone who is cruel enough to conduct experiments like those of the Nazi scientists would not be stopped by the mere lack of citation of their work. Also, as Baruch Cohen suggests, "in the situations where experiments are performed because the scientist is being paid or ordered to administer them, the threat of non-citation would hardly deter him" [1].

Another compromise would be to use the data and include an explicit condemnation of the Nazi experiments. However, one can argue that this is not much of a compromise; using the data, condemnation or not, still confers legitimacy on immoral experimentation [1]. Nonetheless, this compromise is a meaningful proposal, for it would enable a scientist to utilize possibly life-saving data while overtly demonstrating moral revulsion of the Nazi experiments.

> Does the life-saving potential of Nazi data justify their use?

What is the halakhic opinion about the ethics of using Nazi data? In "Utilization of Scientific Data Obtained Through Immoral Experimentation," Rabbi J. David Bleich answers three possible objections to the use of Nazi data. First, Rabbi Bleich deals with the case of King Hezekiah hiding a medical text, an act which, as Rambam explains, was motivated by the law that "everything may be utilized for healing, save for idolatry, some forms of sexual licentiousness and homicide"; the book of cures could not be used because it led to acts of healing associated with idolatry [6]. One may conclude, then, that the Nazi data should not be used even though this information could result in the successful treatment of other people, since the data are derived from another of the three forbidden acts: murder. However, Rabbi Bleich notes that Rambam's explanation of this line from the Talmud can suggest that the book was hidden strictly because it led to prohibited acts of healing; therefore, the halakha cited above does not necessitate that information acquired through immoral acts cannot be used [6].

In addition, Rabbi Bleich discusses the Talmudic requirement that an object used by Bet Din for capital punishment be buried; some rabbis conclude, based on this prohibition, that one cannot derive benefit from such objects nor from any other object involved in death. However, Rabbi Bleich points out that even if the rabbis' conclusion that one cannot derive benefit from any object of death is valid, this conclusion restricts benefit from the objects of death themselves,

and not from information obtained through these objects of death [6]. Therefore, the ban on deriving benefit from an object of death does not correlate to a ban on the use of Nazi data.

The third halakhic objection to the use of Nazi data which Rabbi Bleich considers is based upon the prohibition of deriving benefit from a cadaver. Following this prohibition, some rabbis have suggested that a Jewish medical student violates halakha by examining a cadaver. This halakha, it seems, would preclude the use of Nazi data, as the data were often derived from the bodies of deceased victims. Rabbi Bleich notes that, though there may indeed be a prohibition of deriving benefit, such as knowledge, from a cadaver, this does not necessitate that if the knowledge has already been obtained, it cannot be used. In essence, though the examination of a corpse may violate Jewish law, no posek has forbidden the use of this information once it has been acquired [6]. One can apply this conclusion to the debate about Nazi data, and understand that, though the information was obtained through immoral means, the use of that information is not expressly forbidden by Jewish law.

In addition, Rabbi Bleich cites specific examples which seem to indicate that the Talmud utilizes medical information obtained through immoral means. One such proof is brought from Niddah 30b, which discusses an experiment Queen Cleopatra conducted to discover the point at which the gender of a fetus is determined. The Talmud relates that Cleopatra ordered a group of her female servants to be inseminated and killed 41 days later to prove that gender is set by the fortieth day of pregnancy. (The Talmud accepts the scientific validity of this data because, before the women were inseminated, Cleopatra forced them to take a substance that induced abortion, thereby ensuring that the fetuses were conceived at the onset of the experiment and not prior to Cleopatra's study.) Though this experiment was clearly immoral, the Talmud uses this data, which, according to Rabbi Bleich, demonstrates that halakha does not prohibit the use of data obtained through immoral experimentation [6].

Despite the strong arguments presented by Rabbi Bleich, one can find halakhic opinions which contend that the Talmudic references to immorally obtained data, like the one mentioned above, do not prove that the Talmud unilaterally allows the use of data acquired through immoral means [1]. Indeed, halakha, like ethics, does not clearly offer a definitive conclusion as to the morality of using Nazi data. While this inconclusiveness may seem disheartening to the moral inquirer, in fact, that inconclusiveness need not be entirely discouraging, for it perpetuates the examination of this moral quandary. And the continuing concern with this dilemma may be the best way to ensure that the memories of the victims of the Holocaust, regardless of what we do with Nazi data, are respected, and never forgotten.

Ariella Goldstein is a senior majoring in Philosophy and English Literature. ■

Ariella Goldstein is a senior majoring in Philosophy and English Literature.

Acknowledgements

I would like to thank Dr. Levin for her time, commitment, and invaluable assistance, which greatly improved this article. I would also like to thank Dr. Babich for reviewing my article and for his constant encouragement, without which this article would not be possible. In addition, I want to thank the very wise Esti Zitter for her help with the halakhic section of this article. And last, but certainly not least, I would like to thank Joy Surles, Tikva Hecht, Michaella Goldberg, and Pesia Soloveichik for patiently and deftly critiquing my article.

References

[1] Cohen, B. (1990) The ethics of using medical data from Nazi experiments. J. Halacha Contemp. Soc. 19:103-127.

[2] Daileader, C. (1999) Ethical implications of research results - What is to be done with the results gathered under the Nazi regime? Med.-Moral Newsletter 36:33-38.

[3] Rosner, F., et al. (1991) The ethics of using scientific data obtained by immoral means. NYS J. Med. 91:54-59.

[4] Rosenbaum, A.S. (1989) The use of Nazi medical experimentation data: memorial or betrayal? Int. J. Appl. Phil. 4:59-67.

[5] Schafer, A. (1986) On using Nazi data: the case against. Dialogue. 25:413-419.

[6] Bleich, J.D. (1991) Utilization of scientific data obtained through immoral experimentation. Tradition 26:65-76.

Old Age - an Age Old Aspiration

Yael Grunseid

Deep down inside, each and every one of us desperately yearns for the chance to live a long life. Personally, even as a little kid, I distinctly remember the enthusiastic applause my family gave to the television image of a woman vigorously running on the treadmill as Good Morning America wished her a happy centennial. If longevity is such a blessing, and clearly it is regarded as such, then why is it that we pluck out the gray hairs, avoid birthdays like the plague, and smear on the wrinkle cream like there's no tomorrow? It's a paradox of life that goes beyond semantics- everyone wants to eventually be old, but no one wants to get old. Perhaps if the human lifespan would increase several-fold, then mankind could make peace with process of aging. Interestingly, in early Biblical times, extreme longevity was a fact of life. At the dawn of civilization, the Bible's longest recorded life was that of Methuselah at 969 years... just slightly different from today's average lifespan of 70-80 years! Surprisingly though, the magnitude of the early Biblical numbers differs even from those recorded in later Biblical times, as Abraham's recorded date of expiration is at age 175, while Moses, who lived circa four hundred years later, lived only to the age of 120. These pieces of information raise a series of questions whose answers may hold exciting implications for the world of science today. They are as follows: What are the possible causes of the remarkable longevity found in early Biblical times, and what brought about its sudden and dramatic decrease? Why is it that, until today, people have been left to seek out the elixir of life to no avail? Most significantly, can humanity hope to achieve its lost longevity once again? This issue warrants both Biblical and scientific examination.

The exploration of this topic begins in Genesis 2:17, at the very first moments of human life. There, G-d commands Adam and Eve to refrain from eating of the Tree of Knowledge, as the verse states, "On the day you will eat from it, you will surely die." The text seems to imply that obeying this command will bring immortal life. Ramban on the spot comments on the words, "you will surely die," by saying that this death is not one of an instantaneous nature, for as is clear from later verses, Adam lived a full life of 930 years. Rather, the words "surely die," decree the inevitable process of death and the fallibility of every living creature. This idea recurs with the sin of Adam and Eve in Chapter three of Genesis. There, G-d reiterates the concept of mortality by saying, "for you are made of dust, and to the dust you will return." Following these words, verse 22 contains a very ambiguous statement, "And G-d said, man will become one of us [let us chase him from the Garden of Eden] lest he should stretch out his hand and eat of the Tree of Life and live forever." Ramban continues with his previous idea that the Tree of Life had not been of value before Adam's sin because he already had been created an immortal being, but, with the advent of death to the world, the Tree would override G-d's decree, and thus Adam was banished from the Garden of Eden. These two sources in Genesis highlight the beginning of man's mortality.

Going forward in time, the ten generations succeeding Adam had a collective life span average of 857.5 years [1]. Along with their increased life spans, there is another unusual link between the people of these generations; namely, many of them were able to sire children at advanced ages. Noah is the most extreme example, fathering Shem at the age of five hundred, but, in general, the average age of fatherhood was 117 years [1]. The life spans during the ten generations between Noah and Abraham spiral downward from Shem's six hundred years to Terah's 205. Post-Terah, the life span seems to somewhat stabilize, gradually decreasing with each generation until the days of Moses. As the final figure appearing in the Bible, Moses' age of expiration pretty much sets the maximum age of mortality for humankind thus realizing G-d's declaration to the sinful Flood generation in Genesis 6:3, " My spirit shall not abide in man forever, for that he also is flesh, therefore shall his days be a hundred and twenty years." Subsequent cases of extreme longevity that appear in later Biblical books (e.g., Ruth and Daniel) are based in

Aggadic sources rather than in the texts themselves and are viewed as exceptions from the norm. King David, as a representative of the pre-Temple period, expresses the average mortality age of his generation in Psalm 90; "The days of our years among them are seventy years, and if with strength, eighty years."

Assuming that the time count and length of the years mentioned in the Bible correspond to the system that is currently used (this is explained by the Abarbanel on Genesis 5), the longevity phenomenon begs explanation and is addressed by commentators throughout Jewish history. Josephus, in his book of Antiquities, seems to be the first commentator to attempt an explanation. He launched into his theory of longevity by stating that the early Biblical generations possessed the special status of being "beloved by G-d" because they were the first of His human creations. As such, they were granted lengthy years. These people also adhered to a diet capable of sustaining longevity. Furthermore, Josephus believed that G-d granted extreme longevity so that humanity could live to observe and learn the laws of astronomy [2]. The Rambam was of the opinion that that not all the people of that time lived extended years; instead, long life was limited only to those individuals enumerated in the text. Like Josephus, Rambam attributed this exclusive longevity to diet and a general healthy lifestyle. Though Rambam looked first to natural causes, both he and the Ralbag leave open the possibility that the elongated life spans of these generations can be ascribed to outright miracle [3]. The Ramban, on the other hand, came out strongly against Rambam's idea that longevity was limited to only a few individuals and stated that Adam's "biological perfection" was the reason for his longevity and that of all his early descendents. It took climatic changes caused by the Flood in Noah's time to disrupt the inborn human perfection and bring a gradual end to the longevity [4]. Lastly, the Abarbanel was of the opinion that restraints in sexual activity, as well as in diet were the root causes of the longevity. He highlighted the unusually late average age of paternity for these early generations and attributed it to delays in their adolescent development. He speculated that the delays came as a result of an altered biological clock, which in turn affected the age of mortality [5]. The ideas and opinions of the above-mentioned Jewish scholars were limited by the scientific knowledge of their eras. Remarkably, these ancient and medieval scholars have not fallen far a field from the current possible causes of the longevity offered by modern scientific technology.

R. Schontal, of the University of London, believed that the culprits causing the drastic decrease of longevity in early Biblical times were pathogenic fungi, colloquially termed as "mold." Extensive research in the field of mycology during the last quarter century has shown that the fungal metabolites, called mycotoxins, are "involved in the etiology of many disorders," including fetal and neonatal abnormalities, as well as tumors. Such disorders could result in the decrease of the human lifespan. Microfungi and their mycotoxins are almost as old as the earth itself. Since pre-historic times, the fungi flourished in dampness, such as after a rainfall and in high humidity. After the Great Flood, which lasted for forty days and nights, fungi thrived and proliferated. Schontal theorized that the lifespan decrease of four hundred years that elapsed between the pre-and post-flood generations was due to "deleterious agents" (possibly, mycotoxins) that adversely affected parents before and during their reproductive years and caused malfunctions to occur in their offspring. He further claimed that the advanced age of paternity indicates that "sexual maturity took longer to attain during the pre-flood period." Sex hormones, perhaps, were damaged by the mycotoxin, zearalenone, which is known "to have estrogenic action, and to affect the sex organs...and the functioning of the steroidal structure itself [6]." The research of Schontal is reminiscent of both Ramban's opinion that climatic changes caused by the flood were the reason for the lifespan reduction and Abarbanel's claim that the human biological clock had somehow been altered.

In a completely different approach to the issue, Nathan Aviezer, of Bar Ilan University, asserted that the current scientific consensus is that "the cause of all aging processes is genetic [7]." The progression of aging and death is determined by individual genetic defects, running the gamut from those that trigger the production of chemicals to destroy tissues by oxidation reactions, to others that alter proteins resulting in the rigidity of heart muscle, lungs, ligaments and tendons, and to genes that predispose individuals to Parkinson's disease and diabetes. In the absence of these defective genes, humans could live as long as 1,300 years! Referring back to Adam and Eve, Aviezer proposed that the ancient couple had genes free of genetic defects and hence were theoretically immortal beings. Living in the Garden of Eden, they avoided non-genetic causes of death such as accidents or disease. Once they sinned and were expelled from the Garden, although their perfect genes remained in tact, they were now in danger of environmental elements. As they did not succumb to the deleterious effects of aging, their extreme longevity is understandable, as is their ability to reproduce at advanced ages. Apparently, their deaths and those of their early descendents were attributed to the lack of medical technology, such as antibiotics and immunizations, to pro-

tect them from deadly microbial and viral illnesses. Aviezer additionally called upon William's concept known as antagonistic pleiotropy, and explained that, "the same gene necessary for one important bodily function early in life may sometimes be harmful to the body later in life [8]." Employing this term, Aviezer modified his gene defect-free theory to include genes, albeit in a small number, that would cause aging and eventual death for all humanity - even for Adam and Eve. He proposed that the moment of G-d's decree (Genesis 6:3) dooming man to the limit of 120 years was the point in time that aging/defective genes were instituted into the gene pool. Life span did not immediately diminish to this decreed number because it took time for these genes to establish in humanity. In fact, no aging seems to appear at all in Jewish Biblical literature until the time of Abraham. In Bereishis Rabbah 65:9, the Sages explain that Abraham and Isaac, with almost a century between them, so resembled each other that people would generally mistake them for one another. The lack of physical aging masked the difference of their years. Abraham, seeing that such confusion was robbing all the elder generation of their due respect, applied to G-d to institute the physical symptoms of aging. G-d readily agreed and said, "You request a good thing. I will grant it; and since you asked, I will begin with you." Accordingly, the Bible precedes Abraham's death with a description of old age, as stated in Genesis 24:1, "Abraham became old; he was along in years." Thus, from Adam to Abraham, Aviezer's proposal seems to be plausible as it covers all Biblical bases.

Presently, it remains only to discuss the probability that humans may recover their lost longevity. At this point, it is worthy to mention the recent scientific discoveries that have lead Aviezer and others to believe that they have unlocked both the mystery of the early Biblical generations, and more significantly, the secret of longevity today.

M. Azbel of Tel Aviv University researched the idea of a genetic basis to aging and death and suggested "there exists a genetically programmed ability to die at a given age...that age may be manipulated [9]." Indeed, experimental research does seem to substantiate his proposal. Tom Johnson of the University of Colorado discovered that changing of the gene called Age-1 in nematode worms (Caenorhabditis elegans) doubled their lifespan [10]. In 1992, Michael Rose of the University of California succeeded in establishing a genetic strain of Drosophila fruit flies that lived about twice as long as flies raised in a neighboring laboratory. At every stage of life, these new and improved flies were stronger than the average fly. A third study by Michal Jazwinski identified genes that strengthen and extend the life of brewer's yeast [11].

As exciting and fascinating as the concept of genetic manipulation may be, it can hardly be proven that this is the single reason for human aging, not to mention the considerable bridge to be crossed to extrapolate conclusions from studies with insects to the human beings. So what defines aging and what causes mankind to age? Studies, in the past decade by the researchers Ricklef, Finch, and Hayflick provide a few probable theories [12,13].

...at the end of the lifespan, some areas of the brain possess a whopping 3% of abnormal mitochondrial DNA. Mutations are thus a significant factor of the aging process.

One theory proposes that genetic mutations at the DNA level set in motion the events of aging. Mutations are changes in the DNA of a cell that are passed on to daughter cells during the process of mitosis, or cell division. Changes in DNA, in turn, cause the genes, to encode for defective proteins. A genetic mutation in a significant location can wreak havoc on enzymes, transcription factors, and regulatory proteins that mediate DNA and regulate the individual activities of genes. Notably, the mutations of the tumor suppressant genes, p16 and p35, which slow cell proliferation also accelerate during the process of aging. These mutations raise the risks for an individual to develop cancer [12]. Gene mutations may damage mitochondria, the powerhouses of cells, as they contain their own DNA with which they replicate and encode for enzymes that aid in the production and storage of ATP molecules, the body's form of stored energy. Damage to mitochondrial DNA may cause the loss of functioning of the mitochondria and a reduction in energy production. The storage of ATP molecules may adversely affect brain and muscle function. Thus, for example, at the end of the lifespan, some areas of the brain possess a whopping 3% of abnormal mitochondrial DNA. Mutations are thus a significant factor of the aging process [12].

Not all aging can be explained by genetic mutation. A second theory, called the Free Radical Theory,

involves the deleterious effects of free radicals, molecules or atoms that contain unpaired electrons. This instability creates an uneven electric charge and, to regain stability, these free radicals attract electrons by detaching them from nearby DNA, in a process called oxidation. Theorists propose that such oxidations are directly involved in the wrinkling of skin, the loss of flexibility, and rigor mortis [14]. Oxidized lipids may cause arteries to abnormally thicken. Furthermore, the tremors seen in Parkinson's disease, the slowness of motion apparent in old age, and type II diabetes are also associated with free radical induced oxidative damage [12].

It is generally agreed that to some degree, a biological clock gene is involved in human aging. For example, the death of brain cells is "due to regular, programmed cellular destruction." Combining these two facts, the clock gene is theorized to work as follows. As cells divide, the gene monitors the number of divisions. After the cells reach their maximum number of divisions, the gene encodes proteins for cell destruction [15]. In 1961, Leonard Hayllick presented the idea that normal diploid cells, like those of the skin, lungs, and bone marrow, which were at first thought to continually replace themselves throughout life, only divide a limited number of times [16]. Subsequent research showed that as the age of a cell increases, the number of potential cell divisions decreases. The point at which the cells cease to divide is called the Hayflick limit. This concept was furthered by the telomere theory [12]. Telomeres are highly repetitive sequences of nucleic acid bases located at the tips of chromosomes that protect the chromosome from unraveling. In DNA replication, the telomeres of daughter cells become shorter than those in the parent cell. At the Hayflick limit, the telomeres are extremely small and cell division ceases. As protective telomeres are no longer effective, genes produce proteins that cause the destruction of the tissues, a known characteristic of the aging process. In substantiation of this theory, research has found that infinitely dividing cells, such as spermatogonia and cancer cells, maintain their telomeres indefinitely [17]. These cells synthesize the enzyme telomerase, which maintains the telomeres. If this theory held true, then perhaps a boost of telomerase cells, if somehow separated from their counterpart cancerous mutations, could be a possible key to human longevity.

Though the above theories point to genes as only the perpetrators of disease and aging, a groundbreaking study published in August 2001 by geriatrician Dr. Thomas Perls and geneticist Lou Kunkel arrived at the opposite conclusion. Encouraged by previous research maintaining that the alteration of just a few genes in fruit flies caused noticeable increases in lifespan, and Dr. Lithgow's discovery of a longevity gene in worms in 1994, Perl and Kunkel set out to find such parallels in the human genome as well. They conducted a study comparing 137 pairs of siblings who had each respectively reached beyond the ages of 98 and 91. Remarkably, they found that in a significant number of these cases, the elderly sibling-pairs shared uncanny commonalities of DNA in small genetic regions located on specific areas of chromosome 4 that could not be credited to chance [19]. Additionally, many of the participants in the study enjoyed decent physical condition despite lifelong tendencies toward unhealthy eating and smoking. Thus, the researchers posited that a handful of genes - yet to be determined - found on chromosome 4 might well be responsible both for human longevity as well as for deterring the degenerative diseases associated with aging. As thrilling and novel as this discovery is though, it is presently only in its beginning stages. Researchers will have long roads to pave before they can pinpoint the exact genes that are the key to longevity. In Dr. Perls' own words, "If we were looking all over the world for a clue to exceptional longevity, we might say we have now found the city. But to find the clue itself, we have to find not only the apartment, but the kitchen sink in that apartment where that clue is actually located [20]."

In another vein, an article in the Washington Post on September 4, 2001 reported yet a different theory on aging. Stephen Spindler of the University of California proposed that drastic calorie reduction could reverse the process of aging. In his study, Spindler put elderly mice on a four-week low calorie diet. The diet reversed the activities of many genes that normally function in the aging process. Spindler said, "My work shows that calorie restriction not only prevents (age-related) changes, but quickly reverses the majority of changes that take place with age [18]." Though his theory is proven in mice, Spindler's low calorie diet remains unproven in humans.

As theories and research on aging abound, there are no definitive answers to date. However, with the fast pace of current research and scientific technology it remains only a matter of time before mankind reaches longevity once again. The possibility of a world without aging seems fascinating, yet scary, as it would change the face of the humanity as we know it. Yet, such a world is not novel; it did exist for Adam and Eve many thousands of years ago. With the right touch of telomerase and with an appropriate diet, humankind may find itself marching to an older tune...and, who knows, knee-length gray beards may be the height of fashion again sooner than we think!

Yael Grunseid is a junior majoring in Psychology.

Acknowledgements:
Thank you Dr. Babich for all your encouragement, support, and especially for your constant smile. To my parents: Long life would be worthless without you! Thanks for being there twenty-five hours, eight days a week!

References

[1] Genesis 5, as cited in: Kaplan, A. (1993) Immortality, Resurrection and the Age of the Universe: A Kabbalistic View. Ktav Publishing House, Inc.: Hoboken, New Jersey, p. 20.
[2] Josephus. Antiquities 1:3:9. As cited in: Kaplan, A. (1993).
[3] Moreh Nevuhim 2:47
[4] Ramban on Genesis 5:4. As cited in: Kaplan, A. (1993).
[5] Abarbanel on Genesis 5. As cited in: Kaplan, A. (1993).
[6] Schontal, R. (1987) Mycotoxins, the Flood, and Human Lifespan in the Bible. Korot 9:503-506.
[7] Aviezer, N. (1998) The Extreme Longevity of the Early Generations in Genesis. Bekhol Derakhekha Daehu 7:5 14.
[8] Williams, G.C. (1957) Evolution. 11:398-411. As cited in: Aviezer, N. (1998).
[9] Azbel, M. (1997) Physics Reports. 288:545. As cited in: Aviezer, N. (1998).
[10] Johnson, T.E. (1988) Genetics. 118:75-86. As cited in: Aviezer, N. (1998).
[11] Rusting, R.L. (1992) Scientific American. December 1992: 87. As cited in: Aviezer, A. (1998).
[12] Ricklefs, R.E. & Finch, C.E. (1995) Aging. Scientific American Library: New York.
[13] Hayflick, L. (1994) How and Why We Age. Ballantine Books: New York. As cited in: Aviezer, N. (1998).
[14] Kronhausen, E. et al. (1989) Formula for Life. William Morrow and Company, Inc.: New York, NY.
[15] Keeton, K. (1992) Longevity: The Science of Staying Young. Penguin Books: New York, NY.
[16] Hayflick, L. and Moorehead, P. (1961) The Serial Cultivation of Human Diploid Strains. Exp. Cell Res. 25: 585–621.
[17] Lafferty, E. et al. (1996) Can We Stay Young? Time Magazine. 25/11/96:53-62.
[18] Okie, S. (2001). Low Calorie Diet Slows Aging in Mice Study. The Washington Post. 9/4/04: A10.
[19] Infoaging. http://www.infoaging.org/feat10.html. (retrieved January 27, 2005)
[20] PNAS. http://www.grg.org/TPerlsl.htm.(retrieved January 27, 2005)

Interface of Halacha and Genetic Engineering

Shuli Kulak

Genetic engineering, often described as the manipulation of an organism's genetic material to modify the proteins that are synthesized, has allowed mankind to manipulate life in a way our ancestors could never have imagined. Today, it is possible to identify, isolate, and extract genes, the genetic units responsible for expressed traits, from one organism and insert them into a wide array of different species, i.e., process of the creation of transgenic organisms. These newly implanted genes give the developing embryo novel instructions to express physical and chemical characteristics that were never exhibited by that species, but that will now be manifested in all its future generations. The initial task is to isolate the gene from one species and insert it into the fertilized egg of a different species. This foreign gene, now inserted to the nucleus of a fertilized egg, may permanently integrate into a chromosome of the egg. Through growth and division of the fertilized egg, all the daughter cells will also have the added foreign gene. Eventually, the growing embryo, with its new genetic constitution, is implanted into a surrogate mother.

Such scientific technologies have led to biologic innovations, such as anti-freeze strawberries, achieved by isolating the gene from a salmon that prevents it from freezing and inserting that gene into the genome of a strawberry. Other interesting concoctions include glow-in-the-dark houseplants, synthesized by inserting the glow-in-the-dark gene from a jellyfish into the genome of a houseplant. Applications of such technology are in the not so distant future. Currently, in the United States, 45% of the corn crops, 85% of the soy crops and 76% of the cotton crops are genetically modified [1]. Thus, apparently, human consumption of genetically modified produce is quite common, albeit, not publicized to the populace.

Unscrambling and re-scrambling DNA, the blueprint for all life, is what scientists, lawyers, businessmen, and philosophers have been studying, testing, debating, and analyzing for the last 45 years. More recently, rabbis have been concerned of the halachic implications of genetic engineering. Such innovations, as the anti-freeze strawberry have lead to an interesting question: what blessing is required upon consumption of such a fishy fruit, the blessing for a fish or for produce grown from the ground?

If one looks to the future of genetic engineering, this type of question can be taken a step further. Scientists may soon be able to isolate the gene that causes an animal to chew its cud. When this day comes, and someone introduces this gene into a pig's fertilized egg, the resulting animal may express both signs for a kosher species: a chewing of the cud and a splitting of the hoofs. Is this animal kosher?

Answers to such halachic questions depend on many issues, however two of most significant are kilayim and simanim, the prohibition of mixing species and the designation of the physical symbols of the kashrut on animals, respectively. The issue of kilayim, commonly equated with grafting and interbreeding, is explicitly banned by the Bible, "You shall not mate your animal into another species, you shall not plant your field with mix seed" (Leviticus 22:19).

At first glance, it appears that the Bible is directly forbidding interbreeding of animals which would, to say the least, put an abrupt end to halachic issues involved in genetic engineering. However, upon a closer and more informed inspection, the Bible only states that one may not "mate" or "plant" different species. Genetic engineering is initially performed in test tubes and Petri plates and only later involves surrogate motherhood. Hence, as it does not involve the act of sexual reproduction (i.e. "you shall not mate"), it seems that one may be permitted to mix the genes of one species with those of another [2]. However, there are those of note, namely Nachmonides, a 12th century Jewish scholar, and Rabbi Samson Hirsch, a seventeenth century German biblical commentator, who view the above-cited verse differently. They note that the creation of hybrid offspring is inappropriate, because such hybrids modify G-d's original creative intentions and improving the creations of G-d is not the duty of man. Therefore, it is not the methodology of how mixed species are created that is forbidden, rather it is the actual creation of the hybrid offspring that is prohibited. Ergo, the same logic that forbids the mat-

ing or planting of non-synonymous species would equally forbid any other type of genetic manipulation leading to the creation of a transgenic species, as these "creations" alter the original blueprint formulated by G-d. As yet, there is no modern-day resolution to this debate and there are still strong proponents for each opinion. The issue of kilayim is important, not to be trivialized, as it will have major effects on the eventual halachic analysis of genetic engineering.

The other major and extremely interesting issue is the Biblical signs designating an animal to be kosher, i.e., the simanim of kashrut. These laws are outlined in Leviticus 11:9: "Any animal that has true hoofs, with clefts through the hoofs, and chews the cud - such you may eat." Do the simanim, the signs that the Bible predicates kosher animals as having, INDICATE or CAUSE the kosher status of an animal? For example, one can say that a squirrel is inherently a non-kosher species and a cow inherently is a kosher species. Yet, to allow Jews to recognize those species fit for consumption, the Bible gave two specific symbols, i.e. chewing of the cud and a splitting of the hoof. The implication of this definition of simanim is that even if a specific member of a kosher species does not bare the signs of kashrut, it is still considered kosher because its species has been designated as kosher. On the other hand, it can be argued that the actual split hoof and cud chewing is what makes the animal a kosher animal. With this explanation, the simanim are the actual causes of the kashrut status of the animal. This would imply that a pig, a non-kosher species, through some natural mutation or genetic manipulation would possess the simanim of kashrut, it would, in fact, be kosher. Ostensibly, one would be inclined to say that this new transgenic pig is kosher, as it meets all the Bible's specifications. But, with a closer look into the gamut of rabbinic literature one will find many opinions that support the opposite case.

"...[T]hat which issues from the impure is impure and that which issues from the pure is pure" (Berachot 1:2). This statement made by first century Rabbis seems to unequivocally imply that it is status of the mother that defines the kosher status of the offspring. But if one continues to read, the Gemara rules that "one might have an animal that chews its cud and has true hoofs, yet is not to be eaten. And what might that be? A pure animal born of an impure one." This seems to unambiguously tell us that the simanim are merely symbols to delineate kosher status.

One clear distinction must be made. The previous discussions pertained to only non- oviparous mammals. Birds are an entirely different issue, as organisms hatched from eggs are -halachically speaking - are not considered as "coming" from the mother which laid them because the mother did not gestate her young internally. Instead, the instant after an egg is laid, it is considered as dust, not fit to be eaten, and not deemed alive. Only after a period outside the mother's body is life considered to form inside the egg (Temurma 31a)[3]. There are however, other opinions (Rambam, Hilchot Ma'akhalot Assurot 3:11 as explained by the Maggid Mishneh) [2] that hold that since the kashrut status of eggs are determined by the animal that lays them, the same principle can be applied to the kashrut status of birds that hatch from those eggs. But, the latter view, in a sense, detaches the child from the parents, thereby shaking off any status of the parents. Fish also have a different status because the rabbinic liturgy never included them in the ruling of: "what issues from impure is impure," and because some species are hatched from eggs. Thus, one can make an even more convincing argument that a non-kosher animal, which is born by hatching, can be genetically modified with the proper simanim and be considered kosher.

The future is approaching quicker than anyone can keep up with. These theoretical discussions seem to be esoteric and far from practical now., but soon they will be our daily reality. The effects of humanity's recently harnessed genetic powers will be felt in strange but profound ways and Jewish law (halacha) will, as it always has, respond to it.

Shuli Kulak is a senior majoring in Biology and minoring in Business.

Acknowledgements:

Firstly, I want to acknowledge and show gratitude to my parents for building the foundations for my deep love of Hashem, Torah, knowledge, and truth. I want to thank my husband, David, for his support. I also want to recognize and thank Dr. Babich and Rav Tabory for editing my article and constantly exciting, motivating, and encouraging me, and all the students that come into contact with them. Their devotion is a true inspiration.

References:

[1] The Pew Initiative on Food and Biotechnology. http://www.mindfully.org/GE/2004/US-GMO-Crops-Pewlaug04.htm (retrieved December 25, 2004)

[2] Bleich, J. (2004). Genetic Engineering. Tradition. 37: 66-87.

[3] Bar Ilan University Website. www.biu.ac.il (retrieved January 9, 2003)

[4] Anonymous. (2004). Is a non-Kosher Fish that Grew Kosher Signs Kosher. Merot HaDaf Yomi. 252:3-4.

The Evolution of the Missing Tooth

Lenore Ribalt

The practice of dental medicine has presented itself for centuries and the progression of dental technology has been revolutionary. Replacement and restoration of defective teeth evolved slowly from ancient techniques to modern dental science. One of the earlier developments for tooth replacement is revealed in the halachic discussion as to which ornaments a woman can walk out with on Shabbat. This discussion, stemming from a Mishna in Shabbat (6, 5) states, "...An artificial tooth and a gold tooth, Rabbi Meir permits and the Sages forbid." Rabbi Meir and the Sages' disagreement as to where a woman can carry gold or artificial teeth in public territory refers to the prohibition of carrying objects in a public domain on the Shabbat. Maimonides' commentary on this Mishna differentiates between gold and artificial teeth. He explicates that an 'artificial' tooth is a false tooth affixed into the mouth in replacement of one that has fallen out. Maimonides explains that a gold tooth is that which, "is on top of a black or red one;" gold was used as an aesthetic crown over a natural tooth to conceal tooth defects [1]. Maimonides, a physician himself, explained the etiology of defects. He clarified that a black tooth is a result of dentin being stained by degraded blood cells as a result from a hemorrhage in the pulp; a healthy tooth losing its natural color inevitably turns black. A red tooth occurs when inner portion of the tooth is degraded by caries, leaving a thin translucent strip of enamel on the outside. Blood vessels from the inner portion of the tooth project a red coloring through this transparent layer [2].

False teeth were also produced from wood and silver. The Talmud Yerushalmi (Shabbat 8:8c) relates an incident of a woman ashamed to go to the carpenter in request for another tooth replacement. From this, it is clear that wooden teeth were used as tooth replacements and that they were fashioned by carpenters. "Wood chips" or toothpicks were also used to help align teeth. The use of silver teeth is mentioned in the analysis of the above-cited Mishna as to the difference between a gold and silver tooth. Rabbi Meir and the Sages's conflicting opinion as to whether gold is permissible is juxtaposed to the portion of the Mishna that says, "...but with a silver tooth, they agree that it is permitted" [3]. The Commentaries further discuss that a silver tooth is indistinguishable from another tooth and does not have the same considerations as the gold tooth. It is possible, at that time, that teeth in general were darker-stained and discolored, allowing a silver tooth to blend in with the rest of the teeth. Rashi offers an opinion to those who argue that gold teeth are forbidden for use on the Shabbat. He states that a woman may be tempted to remove her gold tooth and flaunt it to her friends, causing her to violate the prohibition of carrying of objects in public domain on Shabbat [4]. Another option is that the Sages forbade the use of a gold tooth on the Shabbat as opposed to a silver tooth, simply due to the fact that gold tooth is more conspicuous and may cause others to notice and ridicule her. Feeling discomfited, the woman would potentially remove the gold tooth in public domain, violating Shabbat. Those who permit the use of gold teeth on Shabbat argue that the woman will not remove the gold tooth in embarrassment of exposing her deformed red or black tooth. Both arguments clearly concern the psychological implications of wearing dentures; the argument presented concerns whether the woman would be ashamed or proud of her false teeth [1].

Restoration of teeth has clearly come a long way since the Neolithic era. Early evidence of dental implantation is found in skulls of natives around 600 B.C.E., where carved shells were found in tooth sockets [2]. Ancient Egyptians also used their own materials to replace missing teeth. Although there is no documentation, Egyptians most likely used ivory for restoration purposes [5]. Tooth studies from the 17th century, revealed that some teeth once had a "three unit restoration carved of bone." This prosthetic restoration was done through silver pins inserted to the tooth's root canal. In many cultures believed in the importance of esthetics; various tribes, such as the Mayas, would utilize precious stones in teeth to enhance their appearances [2].

Currently, dental implants are used for tooth restoration. Introducing the concept of "osseointegra-

tion" [2], Professor Per-Invar Branemark from Sweden, initiated the extensive practice that spread to North America. Dr. Branemark demonstrated that titanium could potentially be inserted into live bone and survive without causing inflammation or fixture rejection [6]. An osseointegrated implant, commonly known as a dental implant, is an artificial titanium fixture used in replacement of a natural tooth's root. The cylindrical implant is surgically placed into the upper or lower jawbone where the tooth is missing, serving as an "anchor" for the replacement tooth. Roots hold natural tooth into the jawbone. Similarly, bone forms around the titanium implanted into the jaw, allowing the implant to hold crowns, bridges, or dentures [7]. Implants are advantageous not only in their success rate, but in that they do not apply pressure to, or affect, surrounding teeth. They support the replacement of individual teeth needed for restoration. However, restoration may be quite lengthy; this process can take nine months since the jawbone must grow and circumvent the implant. In addition to the time factor, expense plays a major role in this treatment. Each patient who undergoes dental implantation obtains a customized plan, which requires highly skilled professionals to administer the treatment. Furthermore, much of the expense is due to the diverse materials, precious metals and various forms of scans to comprehensively diagnose the patient. Most dental health insurances do not cover the expenses of dental implants [8].

Strides in tooth reconstruction have exponentially transformed modern dental science. Much research has been directed to the regeneration of exposed pulp tissue caused by damaged teeth. For decades, dental material has been used to cover exposed pulp and to restore tooth structure. Ultimately, this gives the cells that comprise the pulp the possibility of regenerating. Direct pulp capping prognosis is quite reduced and there is a low rate of success after treatment. Therefore, dentists may opt for a "pulpotomy" of selected portions of pulp. Stem cell therapy is a currently a newfound engineering method of regenerating tooth tissues. Pulp cells grown in vitro proliferate into "odontoblastoid stem cells," which could potentially act as an excellent source for new tooth cells. These odontoblastoid stem cells are crucial, in that they immediately begin the regeneration process; these stem cells differentiate, proliferate, and migrate to the injury sites prior to the initiation of reparation. Secondly, odontoblastoid stem cells eliminate the ethical conflict regarding fetal stem cell therapy, as these cells are derived solely from mature human pulp. The current discovery of adult human pulp has been groundbreaking and scientists are meticulously attempting in the goal of restoring teeth for those who have lost or extracted teeth. Tissue engineering science techniques are slowly being implemented into adult human pulp stem cell research in hope of utilizing them in the near future [9].

Successful restorative dental treatment will ultimately transform the economics of oral health within the United States. Around sixty billion dollars are spent yearly on dental work, which continues to increase because two-thirds of restorative dentistry generally fails [7]. By introducing stem cell therapies, more teeth could potentially be saved, significantly lowering the constituency who wear dentures or implants. Discovery of cells within the tooth that differentiate into odontoblasts sheds light on oral health, potentially improving the quality of life for many.

Lenore Ribalt is senior majoring in Biology and minoring in Sociology

Acknowledgements

I would like to thank my parents and siblings for providing me with boundless love and support as well as the encouragement to persevere, explore, and think critically in all my endeavors. Also, I would like to thank Dr. Babich for all the inspiration.

References

[1] Tal, M. and N. Stern (1976) References to dentistry in the Bible and Talmud, Isr. J. Dent. Med., 25:E11-E14.
[2] Stern, N. and R. Sreter (1996) Prosthodontics - from craft to science, J. Hist. Dent., 44:73-76
[3] Rosner, F. (1994) Dentistry in the Bible, Talmud and writings of Moses Maimonides, Bull. Hist. Dent., 42:109-112.
[4] Blustein, A.M. (1975) Denture psychology in the Talmud, Quintessence Inter., 5:81-82
[5] Fagar, M. Jr. (1990) Historical Events of Implant Dentistry, Implant Prosthodontics, In Surgical and Prosthetic Techniques for Dental Implants. Littleton, MA, Yearbook. pp. 4-8.
[6] History of Dental Implants http://dentalimplants-usa.com/Treatment/Implants/history.html
[7] What are Dental implants? http://dentalimplants-usa.com/Treatment/Implants/implantwhat.html
[8] How long does it take? http://dentalimplants-usa.com/Treatment/Implants/howlong.html
[9] Peter E. Murray, P.E. and F. Garcia-Godoy, 2004, Stem cell responses in tooth regeneration, Stem Cell Dev., 13:255-262.

Not Just Chopped Liver

Aliza Weg

The bovine liver is a familiar treat at Jewish smachot since it is often made into a delicious delicacy: chopped liver. More important to us than chopped bovine liver is the human liver. The human liver is a vital organ of the human body and a person's health is strongly dependent upon its proper function. The liver is located in the abdominal cavity, below the diaphragm (Chullin 46a) and it houses the gallbladder. The liver has two main lobes that are composed of functional units, termed lobules. A lobule consists of hepatocytes, specialized cells arranged in plates around a central vein. Instead of capillaries, the liver has large spaces lined by endothelium, termed sinusoids that are referred to by the sages of the Gemara in their statement (Chullin 110b), "the liver exudes blood but does not absorb it." The liver's blood supply is distinctive because of its dual sources of blood; from the hepatic artery the liver receives oxygenated blood and from the hepatic portal vein it receives nutrient-filled blood from the small intestine.

In Exodus 29:13, when discussing the inauguration rituals performed to consecrate the High Priest, the Torah makes note of the liver: "You shall take all the fat that covers the innards, the diaphragm with the liver, the two kidneys and the fat that is upon them; and you shall cause them to go up in smoke upon the Altar." The Torah refers to the liver as yoteres hakaved, which the biblical commentators, Onkelos and Targum Yonasan, explain to mean the "heaviest" visceral organ. In fact, the liver weighs about three pounds and is the largest visceral organ in the body [2].

As noted in Bechorot (55a), the liver is one of the most important organs in the body, for it is "the source of blood" [3]. This rather modest phrase has many ramifications in human physiology. The liver has several functions, which include the manufacturing of plasma proteins, many of the proteins found in blood. The major liver-derived plasma proteins include albumins, globulins, fibrinogen, and complement. As a unit, these plasma proteins help maintain the osmotic pressure, pH, and viscosity of the blood. Specifically, each plasma protein has its own important role. The albumins maintain blood volume and pressure, the globulins are transporters of lipids in the plasma, fibrinogen is important in blood clotting, and complement fights infection. Furthermore, the liver regulates the level of proteins, fats, and glucose in blood. The liver is involved in the turnover of old red blood cells, stores iron (Fe[II]), and removes bilirubin, a breakdown product of hemoglobin, which it later excretes in the form of bile [1].

As an organ of detoxification, a function of the liver is to purify and detoxify the blood from poisonous substances absorbed during food digestion. For example, any foods that are ingested contain lipid-soluble pesticides or industrial contaminants (e.g., polychlorinated biphenyls [PCBs]). Hepatic enzymes transform these chemicals into water-soluble substances that can be eliminated by the kidneys. Many poisonous substances are eventually deposited in the liver to be detoxified [1]. Thus, bovine liver, although usually eaten as a delicacy, may be an unhealthy food item, since, in addition to being rich in cholesterol, it is a reservoir of toxicants. This may be the rationale for the statement in Abodah Zarah (29a) that eating liver can make a patient's illness more severe [3].

The production of bilirubin by the liver has a potential impact on the day of a bris milah (circumcision). Bilirubin, a yellowish pigment produced from the breakdown of hemoglobin, is metabolized by liver enzymes into a water-soluble form, to be transported to the kidneys and excreted in urine. Normal bilirubin levels range from .25-.75mg/100mL of blood serum. Because newborns have an increased amount of red blood cells and their red blood cells have a shortened life span, coupled with their low level of hepatic enzymes, the bilirubin of a neonate may accumulate, causing a marked yellowness of the eyes and skin (physiologic jaundice). The initial appearance of physiologic jaundice in all newborns is normal. By the eighth day after birth, most infants' enzymes are fully operating and their bilirubin count is about average. According to

halacha, all eight-day old, healthy Jewish males are circumcised, as stated in Genesis (17:12), "at the age of eight days old every male among you shall be circumcised throughout your generations." Although the Torah states that circumcision occurs after eight days, a physician may request that the baby's circumcision be postponed if the baby shows signs of jaundice with a highly elevated bilirubin level. An extreme level of bilirubin, e.g., above 20mg/100mL of blood serum, allows the bilirubin to penetrate the blood-brain barrier, where it may cause brain damage [4, 5].

As was mentioned previously, the liver metabolized bilirubin into a watersoluble substance, which then combines with bile to be stored in the gallbladder. Knowledge of this phenomenon is hinted at in Brachos (61b), "the liver rages with wrath, (then) the gallbladder throws into a drop (of liquid) and thereby placates it." Rabbi Yaakov Dovid Lach [6] quoting Rabbi Yisroel Belsky, Rosh Yeshiva of Yeshiva Torah Vodaas and Posek for the Orthodox Union, explains the possible denotation of the Gemara's obscure language. The liver's intense force refers to the production of bile, which, through its detergent-like action, emulsifies large droplets of lipids into smaller ones. The bile then moves to the gallbladder until directed to flow into the small intestine to aid in the digestion of fats. The gallbladder uses a mechanism that signals to the liver that the gallbladder is full and cannot hold any more bile, which "thereby placates it."

The explanation suggested by Belsky is termed entherohepatic circulation. This refers to the circulation of bile salts, one of many components that make up bile, from the small intestine to the liver. The liquid that Rabbi Belsky mentioned may be bile salts that travel from the liver to the gallbladder to the small intestine and then back, via the hepatic portal vein, to the liver to be reabsorbed. To regulate the secretion of bile into the gallbladder, both positive and negative feedback take place. Due to the presence of bile salts in the portal blood flow, the liver is stimulated to produce bile salts and acids, thus characterizing positive feedback. As the intensity of the bile salts increases, the production of new bile acids is subdued, characterizing negative feedback [7].

Blood clotting is of obvious importance, as it is possible to bleed to death if the liver's malfunctioning results in the lack of clotting factors, fibrinogen. The significance of blood clotting can be seen in Gittin (69a) where conflicting opinions of Rav Ami and Rav Ashi are found. Their argument focused on the issue of vomiting blood, known as hematemesis. While the source of hematemesis is clinically more often the gastrointestinal tract, bleeding may originate from the lung or from other organs in the abdomen that connect to the gastrointestinal tract, such as the liver. Rav Ashi agreed with the Gemara that bleeding from the liver, although rare, was more severe than bleeding from the lungs (which itself is termed hemoptysis), which was Rav Ami's opinion. Rav Ami based his reasoning on a Mishna, which referred to a listing of injuries to an animal classifying it as kosher or treif, and noted that a punctured lung was treif. Since the repercussions of a punctured lung were so severe, he suggested that the lungs were more crucial than the liver. Rav Ashi's refutation was based on the fact that the liver rarely bleeds. Therefore, bleeding from the liver implied that the liver was largely or completely deteriorated and was not curable, and such liver bleeding is more sever than bleeding from the lungs. The method that was used to test the source of the blood, whether from the liver or lungs, was to dip a straw into the blood and see whether it adhered to the straw. If the blood did indeed stick to the straw, then it was assumed the blood came from the lungs. However, if the blood did not adhere to the straw, it was assumed the blood came from the liver. These assumptions, apparently, were based on the liver's ability to produce clotting factors [5]. Coagulopathies caused by terminal liver disease are characterized by inadequate clotting factor production by the severely damaged liver and thus, blood clots poorly.

The Gemara, in addition to describing the factions of the liver, paid close attention to its location. Rabbi Yochanan, in Sanhedrin (49a), commented that the liver in humans is located just beneath the right fifth rib. In Tanach, the liver's location under the fifth rib is noted in Samuel II 2:23 and 3:32, when describing the death of Ashael and Abner, who were killed when spears penetrated their fifth rib, which is where the liver and gallbladder "are suspended" (Sanhedrin 49a).

The Rabbis during Tannaitic times had a halachic question about how much of the liver had to be intact for a kosher animal to maintain its kashrus status. Although one opinion suggested that only the slightest amount had to be intact, the majority view, which was accepted as halacha, that only an olive-sized portion had to remain for it to be considered kosher. This opinion was based on the idea that the liver is a vital organ and if absent implied that the animal was doomed, making it a treifah. Rashi explains that this amount is enough to "produce healing." Dr. J.L. Kazenelshon, in Hatalmud Vechochmas Harefua (cited in 6), suggested that Rashi wrote to "produce healing," rather than writing "enough to continue living," because of the liver's regenerative power. The olive-size portion is sufficient for the liver to regenerate and maintain all of the organ's natural abilities. Interestingly, the liver's regenerative ability was not

scientifically documented until 1894.

The Gemara records various kashrus concerns that particularly deal with the liver of a cow. For example, if the animal died due to an injury, it was not considered suitable to eat. However, after fully observing and examining the animal, the status of its kashrus might have changed. If the cause of death was determined to be non-lethal the animal was halachically fit for consumption. The Gemara gives an example of the liver being disconnected from the diaphragm of an animal. Conversely, if the animal's gallbladder was ripped out, or if the liver was disconnected from the inferior vena cava, the animal was not considered kosher. This distinction of whether or not the animal was kosher was based on the significance of the organ that was severed [5].

The liver played a rather unusual role in ancient times. In Ezekiel 21:26 it is written, "For the king of Babylon stood at the parting of the way, at the head of the two ways, to use divination: he mad his arrows bright, he consulted with images, he looked into the liver" [3]. One might wonder why the liver is mentioned in this pasuk, for it might appear that there is no connection between the king and the liver. However, this practice performed for over 1500 years was specifically used to help guide a king. The animal liver was neither examined by a physician nor used for medical purposes, but rather, it was observed by an "inspector," trained to interpret information produced by this organ. This ancient practice, called augury, was a form of advisement, mainly for strategies relating to public and military concerns [8].

The liver was viewed throughout history as a crucial organ in the body. Many of the biological properties of the liver were identified without the use of modern scientific technology. It is fascinating to think how the knowledge of the liver during Biblical and Tannaitic times could be the foundation for the scientific findings known to man today. ■

Aliza Weg is a sophomore majoring in Biology

Acknowledgements:

I would like to express my sincere gratitude to my parents for their encouragement and support as well as to my brother Shlomo Weg, who reviewed this article. I would also like to thank Rabbi P. Oratz for reviewing the Torah content in this article, Dr. J. Weisburg for his input, and Dr. H. Babich for reviewing my article, as well as for his guidance, encouragement, and continual direction.

References

Mader, S.S. (1998). Human Biology, Fifth Edition. McGraw-Hill, NY.

Mount Carmel. http://www.mountcarmelhealth.com/healthinfo/adult/liver/liver.shtml (retrieved August 15, 2004).

Rosner, F. (2000). Encyclopedia of Medicine in the Bible and Talmud. Jason Aronson Inc., Northvale, NJ.

Oppenheimer, A (2003). Jaundice and brit milah: a halachic response to modern medicine. J Halacha Contemp Soc, 45:25-48.

Westreich, M. (1990). Liver disease in the Talmud. J Clin Gastroenterol. 12:57:62

Lach, YD (2004). Chullin Illuminated. HaMedisvta Publications, NY.

Department of Molecular Physiology and Biophysics at the University of Vermont. http://physioweb.med.uvm.edu/gi_physiology/digest_absorb_fat/regulation_bile_secretion.htm (retrieved July 30, 2004).

Lieber E., 1988, "He looked in the liver" (Ezekiel 21:26): the medical origins of liver divination, Koroth (special issue) 9:235-245.

Jewish Genes: References to Genetics in the Torah

Sarah Weinerman

The Bible and Talmud are honored and studied as sources of Jewish law (halacha) and tradition. However, they also contain knowledge about and insight into many other areas of study. This article discusses references to genetics in both of these sources.

The Talmud seems to be familiar with various genetic concepts. In Chulin 69a, the Gemara states that a ben pekuah, a fully developed fetus found inside the womb of a slaughtered animal, is permitted for consumption. However, if the ben pekuah protrudes its limb before its mother is killed, then that limb is prohibited, while the rest of the animal may be eaten. The Gemara considers the situation in which the ben pekuah that protruded its limb lives and has an offspring and discusses whether the entire offspring or the simply the limb corresponding to its parent's forbidden limb is prohibited. The Gemara explains that if the position is taken that "a limb gives birth to a limb," then the corresponding limb alone is prohibited. However, if the position that "[the father's] seed is commingled" is followed, meaning that all of the father's parts combine together to produce the offspring, then the entire offspring is prohibited.

The Gemara then rejects the first possibility, that each of the parent's limbs produces each of the offspring's limbs, stating that if this were true, then a blind or lame father would produce blind or lame offspring, respectively [1]. The Gemara's conclusion that "[the father's] seed is commingled" shows insight into the way that genetic material passes from parents to offspring. Genetic information that determines all of the parents' physical characteristics, or phenotypes, is passed to their offspring and determines their phenotypes.

A famous debate regarding whether a person's characteristics are determined by nature or nurture is hinted to in Yuma 47a. The Gemara states that Rabbi Shmuel ben Kimchi could scoop up four kabin (a certain unit of measurement) in his hands. Explaining the reason for his large hands, he says "All women received zarid, but my mother's zarid rose up to the roof." Although Rashi comments that the phrase "rose up to the roof" means that his mother's zarid was the strongest, there is a disagreement as to what is the meaning of the word zarid. One explanation is that it refers to a cereal product of wheat, which Rashi explains pregnant women ate for nourishment. Accordingly, R. Shmuel ben Kimchi declares that his large hands are a result of nurture. A second opinion explains that zarid means semen, meaning that his mother's egg was fertilized by his father's "best" sperm. In this light, his large hands were a result of nature, the genetic material contributed by his parents.

In addition to insight into these debated genetic concepts, the Gemara ostensibly has knowledge of another genetic principle. When many science textbooks describe the history of genetics, mention is made that the first recorded knowledge of sex-linked genetic traits is found in the Talmud in reference to hemophilia. Hemophilia is a sex-linked recessive trait manifested by insufficient blood clotting. Hemophilia A, or classical hemophilia, and hemophilia B are caused by defects in the genes that code for the clotting protein factors VII and IX, respectively. Lacking proteins necessary for clotting, the blood of affected individuals does not clot properly and this can lead to excessive internal or external bleeding upon minor scrapes and cuts.

Healthy individuals have at least one normal gene, termed XH, while those with only the allele Xh have the disease. Since this gene is located on the X-chromosome, hemophilia is more common among males, who have a Y- chromosome and only one X–chromosome, which they receive from their mothers. Heterozygote females, having the genotype XHXh, are healthy, although they are carriers of the trait. This disease's mode of inheritance was determined in 1820, while it was given the term hemophilia in 1839. However, centuries earlier, the Talmud apparently understood the genetics behind this blood clotting disease. The Gemara in Yevamot 64b states that if a women's sons die from their circumcision (brit milah), her subsequent children are exempt from this mitzvah. Rabbi Yehuda Hanasi says that the death of two sons

from circumcision is sufficient to set a precedence, while Rabban Shimon ben Gamliel requires the death of three. Both agree, however, that the phenomenon of insufficient blood clotting is an inherited trait.

Post-Talmudic rabbis show a further perception of the inheritance pattern of hemophilia. The Rambam rules in accordance with the opinion that the mother's third son should not be given a brit milah and adds that this is true even if the sons are from different fathers [2]. The Kesef Mishna notes the basis of this extension, pointing out that the Gemara says "if [she] circumcises her first son," using the feminine term "mala," instead of the masculine term "mal" [3]. This halacha is in line with the inheritance pattern of hemophilia. Women carriers married to healthy men have a 50 percent chance of passing this disease to their sons. Additionally, if a mother is a carrier, there is a chance that her siblings have the gene, as well. Her brothers, who contribute the Y-chromosome only, cannot pass this gene to their sons, but her sisters can pass the trait to their sons. The Gemara continues with a story which confirms this understanding, relating an incident of three sisters whose sons died during circumcision. Upon the birth of a son, the fourth sister approached Rabban Shimon ben Gamliel, who instructed her not to give her son a brit milah. From this Gemara, it is clear that although the term hemophilia is not used in the Talmud, the rabbis had a concept of how this sex-linked disease is transmitted and used this knowledge to exempt potential hemophiliacs from the mitzvah of brit milah [4].

Knowledge of genetics can be traced to an even earlier source than the Talmud—to the Bible itself. Parshat Vayetzei of the book of Bereishit relates a strange incident of how Yaakov seems to use magical means to establish his own flock from that of Lavan. Yehuda Felix, professor emeritus of both Botany and Talmud at Bar Ilan University, explains how Yaakov used genetic concepts, not magic, to build his flock [5].

In his financial negotiations with Lavan, Yaakov requests that rather than pay him wages, Lavan should remove "the spotted and speckled sheep and brown sheep and spotted and speckled goats, and of such shall be my hire" (30:32). Felix explains that the color of sheep and goats is determined by autosomal genes. The dominant color for sheep is white and for goats is black, while the recessive for both is what the Torah terms "spotted and speckled." In this article, S will denote the dominant allele and s the recessive allele of this trait. In this deal, Yaakov gave Lavan all of the speckled (ss) animals currently in the flock and tended to the remaining flock, which was all dominantly colored, but contained animals of the genotypes SS and Ss. Lavan agreed to give Yaakov all of the spotted animals born from the white sheep and black goats, as Lavan assumed that their number would be few. Ordinarily, Lavan's assumption would be correct; however, Yaakov was able to increase the number of speckled animals born using his knowledge of genetics.

If the SS animals mated with either those of genotype SS or Ss, their offspring would be dominantly colored and would belong to Lavan. To establish his own flock, Yaakov needed to mate the Ss animals with other Ss animals, or perform the monohybrid cross, of which 25% of the offspring are ss. In order to accomplish this, Yaakov needed to distinguish between the SS and Ss animals, although both were solidly colored. The Torah states that "Yaakov took rods...and peeled white streaks in them" and placed them in front of the flocks at the watering troughs, "that they should conceive when they came to drink" (30: 37-38). Yaakov relates that an angel appeared to him in a dream and told him that "the rams that leaped upon the flock were streaked, speckled, and grizzled" (31: 12). In genetic terms, the angel was telling Yaakov that those animals that were first to mate also carried the recessive trait for spottedness. This is in accordance with the genetic concept of hybrid vigor, in which heterozygotes (Ss) have some advantages over the homozygous extremes (SS or ss). Here, the benefit of the genotype Ss is manifested in an earlier readiness to mate. Through this distinction, Yaakov mated the heterozygotes to each other. He separated the homozygote dominant (SS) animals from the flock and gave them to Lavan. The Torah states, "So the feebler were Lavan's and the stronger Yaakov's" (30: 42). Through using the angel's insight into genetics, Yaakov was able to build a substantial flock for himself. Professor William Etkin points out that even though Yaakov could have accomplished this task without the rods, he used them so that Lavan would interpret the extraordinary events in terms of superstitions. Etkin further notes that Yaakov does not mention the rods in his recounting of the dream, indicating that he understood that they were not significant [6].

These pieces of the Talmud and Bible show that knowledge of genetic principles are found within ancient Jewish sources. Perhaps when scientists named Gregor Mendel as the father of genetics, they were a few years too late.

Sarah Weinerman is a junior majoring in Biology.

Acknowledgements:
I would like to thank my parents for guiding and supporting me and Dr. Babich for reviewing and editing this article.

References:
[1] Artscroll Gemara Chulin 69a3 – 69a 4
[2] Maimonides, Mishna Torah, Milah 1:18
[3] R. Karo. Kesef Mishna. Mishna Torah, Milah 1:18
[4] Rosner, F. (1994). Hemophilia in rabbinic texts. J. Hist. Med.49:240-250.
[5] Felix, Y. (1981). Nature and Man in the Bible. Soncino Press, New York, NY, pp. 9-13.
[6] Etkin, W. (1965). Jacob's cattle and modern genetics: A scientific midrash. Tradition 7:5-14.

Bloodletting

Yelena (Leah) Kozirovsky

Retrospectively, it is easy to consider our ancestor's medicinal practices, such as bloodletting, to be barbaric and cruel. Yet, we must understand that from 155 to more than 2,500 years ago the world lacked our medical sophistication and technological advancements. Noninvasive therapies, such as the administration of medication, including antibiotics and radiation to provide biomedical improvement did not exist or were not readily available to the masses, possibly because of the associated expenses and the lack of diagnostic tools. In addition, compared to today's standards of general hygiene and health, the conditions of the middle ages and of Talmudic times were rather poor. Thus, for example, peasants shared the same sleeping quarters with their livestock and viral and microbial infections were rampant because of malnutrition, insufficient heat, the lack of shelter, and unsanitary conditions. Not surprisingly, the natural life span was 40 years. Farmers, because of their hard labor and poor diets, often suffered from joint diseases and showed rheumatic syndromes.

Two thousand years prior to the 19th century, bloodletting, also known as phlebotomy and venesection, was the most popular medicinal cure in most civilizations, including among the Jewish people. The most common modes for bloodletting were through a lancet, the application of leeches, and by the procedure termed cupping. When using a lancet, a vein was punctured and the patient was bled to a prescribed amount. However, when performed inappropriately, the patient would go into a coma [1]. The Talmud describes the instruments used for this mode of bloodletting: a kusulta, or a lancet, and or a masmar, a nail, used to produce the puncture. The procedure was known as ribda (Kelim 12:4).

The other two methods are through leeching and by cupping [2]. Leeches are known as aluka, which is derived from the word aluk, meaning adherence. Leeching was done through placing the leaches on the effected area of the skin. The leeches attach using two sucking organs on their heads and suck the person's blood through the skin [3].

Cupping is known as keren, as originally it was performed with a horn (Shabbat 154b); later, cupping glasses were also used (Gittin 67b). Accordingly, the tip of a horn was removed, the base of the horn was applied to the effected area, and suctioning was done by the mouth at the tip of the horn. The vacuum was maintained by covering the tip of the horn by a finger, wax, or an eggshell skin. This process was termed as dry cupping. However, if this procedure was done through wet cupping, the tip of the horn or any sharp object was used to puncture the effected area, suction was applied to let out the blood and fluids, which were collected. The blood let out from the procedure would flow either to the ground where birds would drink it (Baba Batra 12a) or into old rags (Baba Batra 20a) or a dirty earthenware vessel considered unusable (Baba Batra 20b). Drinking from a cupping glass was considered a despicable act (Makkot 16b). The collection of blood into unusable vessels prevented the spread of disease and infection, as no one would want to come in contact with the blood, either to use it or to ingest it.

Venesection was a very common and well-known procedure in Biblical, Talmudic and the Jewish middle ages. However, it was regarded as a hazardous, yet necessary, procedure with many regulations and guidelines [2]. Throughout the centuries a learned person was not allowed to live in a city without a raphe (surgeon) or a bloodletter [1]. The Talmud (Sanhedrin 93b) explains the verse in Daniel 1:4: "Nebuchadnezzar chose for himself young people without a blemish," that there was not even a lancet puncture on their bodies. In Biblical times (more than 3,000 years ago) it was known that, "In Sodom, if someone injured another and he bled, the injured person had to pay the offender money that the injured person saved since he no longer needed venesection" [2]. The obligation of a husband to pay for his wife's venesection was written in all Jewish marriage contracts (Ketubot 52b). In Egypt, even children less than a year old were phlebotomized [2]. The bloodletter, who also functioned as the barber, was not viewed

as an esteemed person in society. He ranked at the level of a shoemaker, tailor, or shepherd, and was not allowed to fill any leadership positions.

Until the 19th century, bloodletting dominated as the necessary and primary source of treatment for every illness and even as a preventive measure. Scientifically, it was lauded by the major schools of medicine. Accordingly, forefront physicians of the 17th century viewed phlebotomy as the panacea to all ailments. Guy Patin, the Professor of Surgery and Dean of Paris Faculty of Denigrated Surgeons, also known as the "notorious Paris Dean," was among those physicians. He "recommended radical bloodletting and purging [bleeding] a patient 10 times over a span of 2-4 days" [1].

The mechanism whereby venesection inhibits an excessive accumulation of blood in an organ, termed engorgement, which causes great discomfort, dyspnea (difficult and labored respiration), and joint disorders, such as rheumatism (painful and inflamated joints), helped explain the scientific parameters of these pathologies. Talmudic scholars purposed engorgement theories to explain various health risks. For example, humans and animals "overcome by blood," i.e., those who suffer from blood engorgement, congestion, or plethora (a condition in which the excess of blood induces a florid complexion), should be placed in cold water, to shock the body, to decrease blood pressure and inflammation, and to temporarily reduce fever [2]. Remedies, including the use of bloodletting, are discussed in Gitten 68b. For the condition plethora, described as "the blood of the head," as well as for a headache, the primary therapy was venesection, as it reduced inflammation and decreased blood pressure. Inflammation that caused discomfort in effected individuals was relieved by venesection.

In Niddah 19b and in Machshirim 6:5 ff, the differential coloration of blood released through the bloodletting of different individuals is noted and was used as a diagnostic aid for determining the patient's health status. Hence, even today, a smoker's blood appears different in coloration from that of a nonsmoker's blood, because the malfunctioning of gaseous exchange in the lungs of smokers [4].

In the 17th and 18th centuries, leading medical personalities proposed the same engorgement theory as the Talmudic sages and further expanded it to include respiratory and rheumatic conditions. For example, Herman Boerhaave, the Batavian Hippocrates, who was viewed as the most eminent physician from 1668 to his death in 1738, thought that inflammation was due to vascular obstruction of small vessels and that relief could be obtained by bleeding and purging. William Cullen from the prestigious Edinburgh School of Medicine, "ardently promoted the benefits of bloodletting, especially in treatment of [fever] and inflammatory disease...and customarily advocated a full bleeding in an adult male ...equating to a pound of blood." To our ancestors, phlebotomy, in its many aspects and practices, served as a readily available procedure that indeed produced physiological improvement.

In the 20th and 21st centuries, investigation into the procedure of venesection generated physiological inferences to explain and to validate the ancestral popularity of the procedure, despite its many hazards. Lesster King, a physician, postulates why venesection was a common remedy for our ancestor. "Venesection originally became established as a major therapeutic agent because it worked...at least often enough to induce confidence." For many, the procedure acted as a placebo. Watson and Condie provide physiological reasons for its therapeutic aspect. "The main object of bloodletting is to diminish the whole quantity of blood in the system, and thus to lessen the force of the heart action...locally ..[to empty] the gorged and loaded capillaries of and inflamed part...topical bleeding produces its effect by diverting the flow of blood from the affected part...relieving the inflammatory congestion." According to Walter B. Cannon, phlebotomy has physiological benefits by targeting and releasing the mood regulating neurotransmitters, catecholamine, epinephrine, and norepinephrine, as the spleen continuously contracts due to bleeding or major hemorrhaging, thereby creating a sensation of euphoria. Lastly, phlebotomy promotes immune defense [1] by removing toxins via the blood and by stimulating the formation of new erythrocytes [4].

Interestingly, many 20th and 21st century physicians implore the same archaic blood letting procedures and phlebotomizing strategies to relieve syndromes of certain diseases. For example, in the Soviet Union the procedure of dry cupping was practiced as the primary therapeutic-relieving procedure for bronchitis and tracheitis. Small, heated glass jars, applied to a person's back for 10-15 minutes, divert blood flow and fluid from the infected area, thereby relieving inflammation and discomfort [5]. Today, phlebotomy is a major component of treatment for porphyra cutena torda, hemosiderosis a conditions in which the blood contains too much iron, and for polycythemia vera [9], a pathology whereby fragmented erythrocytes horde oxygen from the healthy erythrocytes. Apparently, phlebotomy reduces the blood iron level, thereby promoting the synthesis of new erythrocytes [4].

Two recent studies, one on the treatment of croupous pneumonia [6] and the other on the treatment of rheumatic gonitis via bloodletting and cupping [7]

produced very impressive results. Both showed the clinical effectiveness of bloodletting in the removal of painful and destructive symptoms. In the study that addressed croupous pneumonia, a hoarse grating cough coupled with pneumonia, treatment with cupping and venesection were performed in the early and late stages of the malady. Interestingly, in early stages of croupous pneumonia, not even full doses of morphine injections were as effective as wet cupping, in which the area formally under suction was bled. In the advanced stages of the disease, these procedures relieved engorgement and diminished pain and dyspnea. The author noted that no therapy was better for the later stages of the disorder than bloodletting at the effected sites. Apparently, engorgement of the right side of the heart from severe fluid build up in the lungs signaled "intense dyspnea." Prior to bloodletting, the patient displayed a breathing rate of 50 breathes/minute or higher, a labored and shallow breathing, and a weak pulse. After venesection at the effected site, the patient's pulse improved and breathing became less frequent, less labored, and deeper. This relief was due to the diversion of fluids, thereby unloading the stress on the heart and lungs, and the lessening of inflammation and the restoration of healthy respiration [6].

The other study noted that patients who have undergone acupuncture therapy coupled with venesection were clinically cured from rheumatic gonitis, unlike the control group who only underwent acupuncture. Prior to the course of treatment, both groups had blood sedimentation levels of anti-O at 500 or higher. However the group who received a coupled treatment of bloodletting and acupuncture had their blood sedimentation levels "return to normal," unlike those of the control group [7]. These modern day studies and physiological explanations elucidate the benefits of bloodletting in providing health benefits to their subscribers.

Remarkably, the Talmudic physicians and sages presented very progressive ideas and inferences in respect to our modern knowledge of medicine and physiological processes, especially in the field of diseases, infections, and general well-being. Phlebotomy, as previously stated, was viewed with great seriousness and precaution. Accordingly, the sages set up guidelines to prevent infection and undesirable side-effects of this procedure. Maimonides ruled "that before bloodletting the patient should recite a supplication to G-d for healing and after the treatment one should say, 'Blessed are you, Healer of the living." Mar Samuel suggested that venesection be performed every 30 days and that it be diminished in frequency as one ages (Shabbat 129b). Maimonides, in his Laws of Medical Dispositions and Medical Aphorisms, stated that, as a general rule, one should not phlebotomize children younger than 14 years of age or adults over 70 years of age. He also stated that one should judge the person's well being to determine the suitability of the procedure.

Prior to pre-procedure guidelines, Maimonides excluded certain groups from bloodletting, despite their proper age, because the side-effects would prove to be highly dangerous and uncomfortable. He stated that individuals with convulsive disorders, severe insomnia, anginal type pain, morbidly obese, inordinate anxiety, diarrhea, or colitis should not be phlebotomized [2]. A majority of his statements was affirmed by Fran Allan, manager at NYU Blood Bank, who noted that phlebotomizing those with convulsive disorder would induce an attack. People with anginal type pain may think they are experiencing a heart attack; those with extreme anxiety may have a panic attack, which would increase their blood pressure. Individuals with diarrhea are either at risk of dehydration or already are dehydrated; as such, being phlebotomized would only cause further dehydration. For those with colitis, the procedure may induce diarrhea and dehydration [4].

Conditions stated in the Talmudic pre-procedure regulations were as follows: Mar Samuel "requires that the person to be bled be absolutely fasting" and "if one eats wheat grains and then lets one's blood, he has bled for the wheat, but the sick body obtains no benefit" (Shabbat 129b) [2]. This is understandable, because eating before the procedure will divert the blood flow for metabolic use and, hence, the effected area will not experience the maximum benefit [4]. A dangerously low blood pressure may also result. In addition, a patient bled to the state of coma may aspire [8]. Mar Samuel also states that one should abstain from eating small fish, vinegar, and cress prior to bloodletting because these foods are considered dangerous to the person who will be phlebotomized (Abodah Zarah 29a) [2]. Vinegar is a diuretic, and so if coupled with bloodletting, may lead to dehydration. Yet the Talmud's advanced knowledge of cress and its nutritional values are highly impressive. Cress is an antioxidant and supplies vitamin K, which acts as a blood thinner. Hence the person's blood will not be able to clot properly and, in some cases, severe hemorrhaging and unnecessary infection may follow, due to the delay of blood clotting [4]. Such examples demonstrate the Talmudic insight into hematology.

During the bloodletting procedures, several regulations need to be followed. Maimonides states that one should monitor the pulse for changes and note if the patient's pulse becomes faint, as this is a direct indicator for terminating the procedure [2]. Too much blood loss can lead to shock, which can be identified by pulse fluc-

tuation, as well as the general appearance of the patient [5]. The Talmud also notes the usage of the cephalic vein or femoral vein as a source of bleeding. These veins are used today for phlebotomy. One should not blood let in a standing position, as it says in Gittin 70a "five types of people are nearer to death than to life; namely, one who eats or drinks, or sleeps, or lets blood, or cohabits in a standing position" [2]. In actuality, the letting of blood in a standing position is very uncomfortable, as it constricts blood vessels and makes the procedure difficult. It also lowers blood pressure drastically, making the person feel week and dizzy, which in many cases leads to fainting [4].

The Talmud cautions that venesection should not be done under certain weather conditions. "Certain wind directions prevail might be dangerous for bloodletting" and "not to perform the [procedure] on a cloudy day if one can equally well carry it out by light of clear day "(Shabbat 129b; Yebamot 72a) [2]. Cold weather also constricts veins and makes the procedure difficult and dangerous [4].

Several regulations apply post-bloodletting. After venesection the Talmud states that one should tarry a little and eat something before getting up. In addition, it is highly suggested that one drink right after the procedure (Shabbat 129 a,b) [2]. These practices allow for the individuals blood sugar level to stabilize, so as not to feel light headed and faint when arising. One should also keep away from drafts or chilly places after bloodletting. Catching a chill after venesection was viewed as very dangerous. Therefore, for someone who catches a chill, a fire was made even during the summer to provide warmth; if there was no firewood available, expensive furniture was burned (Shabbat 129a). Today we acknowledge that a chill or exposure to the cold decreases one's immunity, making the person highly susceptible to bacterial or viral infection. During those days, viral and bacterial infections ran rampant, as there were no effective medications for such infections.

The Talmud also cautions against bathing after phlebotomy (Abodah Zarah 28b) [2]. This precaution was most suitable as "in some cases, the bath houses became bordellos. Sanitation was poor and contributed to the spread of disease" [1]. Hence, visiting a bathhouse, one of the only places to bathe in medieval and Talmudic times, was potentially a health hazard. Bath water would disintegrate the scab resulting from a phlebotomy, thereby leaving the flesh exposed to disease-ridden water.

The Talmud also prescribes proper nutrition for the post-phlebotomic patient. Rab recommends "meat, for meat from a strong animal adds to one's strength". Samuel suggests "wine, because red wine makes red blood" and "blood-rich spleen" (Shabbat 129a). The advice about wine was strongly headed. Poor people who underwent a phlebotomy were permitted to present the owner of a winery with a false coin, in order for them to sample some wine. This, "maneuver" could be repeated until the person consumed "one sixteenth of a liter' (Tosefta Pesachim 1:28). As a phlebotomy diminished the blood level of iron, eating meat and blood-rich spleen is an appropriate suggestion. Wine is a relaxant, stabilizing blood pressure. Further, the consumption of cress was advised, as it acts as a blood thinner [4]. The Talmud also suggests that people refrain from any exertion, "particularly traveling and cohabitating" (Gittin 70a). Rest is the best recovery after bloodletting. These points demonstrate the Talmuds insightful and comprehensive knowledge of bloodletting [2].

> Throughout the centuries a learned person was not allowed to live in a city without a raphe (surgeon) or a bloodletter.

It is evident that even a seemingly primitive and barbaric procedure as bloodletting can be very helpful in relieving various pathologies. Most interesting is the Talmuds erudite and progressive knowledge of bloodletting and its effect on the human body. Talmudic sages' and physicians' guidelines and explanations paved the way for future medical exploration and the development of modern advances in practices of therapies in hematology, rheumatology, and respiration.

Yelena (Leah) Kozirovsky is a sophomore majoring in Biology.

Acknowledgements:
I would like to thank Dr. Babich for his support and great help, to my family for their patience and participation, in particular to my father for his constant support and positive attitude, and especially to my grandmothers, Rivveka Margovsky, M.D., for providing essential material and for explaining medical pathologies with their accompanying theories, and Klara Yablonsky, for teaching me analytical thought. I am also grateful to Fran Allen, manager of NYU's Blood Bank, for her incredible help in providing essential material and for being very patient, enthusiastic, and very helpful. To the stern librarians for their aid in web research.To my aunt, Olga Krim, M.D., who serves as an excellent example of a truly great person and a very caring and attentive physician. Also appreciation is expressed to Dr. Eliot Y. Ghatan for serving as a primary example of both Judaism and medicine, to his wife, Aviva Ghatan, for her support, auention, and invitations, to Dr. Irah Sacker for making me very comfortable in expressing myself in the medical field, to Benjamin Neymotin for his support, resources, and editorial help, to Goldy Rosenberg and the Hayam family for their guidance and perseverance, to the nurse (who remains anonymous) at the Palm Estates Nursing Home who provided key information, and to Anya Sedletcaia, the forerunner of this article, and to Master Shawn Ciuraru, Master Joe Huntly and Instructor Ester Kornriech for teaching me about the bodies meridians and physiological processes. Last, appreciation is expressed to my sister, Aliyah Kozirovsky Ratsen, whose constant aid, devotion, motivation, inspiration, counseling, and love has gotten me to the place I am today. Thank you all, especially Aliyah!

References

[1] Schneeberg, N.G. (2002). A twenty first century perspective on the ancient art of blood letting. Transactions and Studies of the College of Physicians of Philadelphia. 24:157-185.
[2] Rosner, F. (1986) Bloodletting in the Talmudic times. Bulletin of New York Academy of Medicine 23:121-122.
[3] Seldletcaia, A. (2002). The blood suckers of today. Derach HaTeva 6:45-47.
[4] Allen, F. (personal communication)
[5] Morgovsky, R. (personal communication).
[6] Tyson, J. (2002) Blood-letting and blistering in treatment of pneumoni Jamma.288.20. Jamma.ama-assn.org/ci/content/full/288/20/2620 (retrieved November 10 2004).
[7] Jianping, D., Yueze, X., and Z. Qingli (2003) Acupuncture and bloodletting. Journal of Traditional Chinese Medicine 23:121-122.
[8] Anonymous (nurse at the Palm Estates Nursing Home; personal communication).
[9] Dr. Eliot Y. Ghatan (personal communication)

Yonah: Man against Nature

Harvey Babich, Ph.D.
Department of Biology, SCW

Yonah ben Amitta's beginnings were quite unusual. According to Pirke d'Rabbi Eliezer (chapter 10), Yonah was the son of the widow in whose house Eliahu HaNavi lived during a famine. This was the same child who died and was revived by Eliahu HaNavi (I Melachim 17:9-24). Yonah was a disciple of Eliahu and, afterwards, of Elisha and was the prophet for the dynasty of Jehu (II Melachim 9:1-10, 10:30, and 14:25). He lived for 120 years.

The Ramban (Bereshis 6:19) notes that when resorting to miracles, HaShem employs an economy of means and causes miracles to happen as close as possible to the natural order. In the entire sefer Yonah, many of the events are an intermingling of overt miracles with natural phenomena.

The sefer Yonah consists of 4 chapters and is read on Yom Kippur. In chapter 1, HaShem commands Yonah to go to Nineveh, the capital of Assyria, and to prophesize that unless the people repent, the city will be destroyed. Yonah, reasoning that repentance by the Ninevites would reflect poorly on B'nei Yisroel, attempts to escape from delivering the prophecy and boards a vessel headed towards Tarshish. However, the vessel is beset in a tempest. The crew realizes something is amidst, as only their vessel was besieged in the storm while nearby vessels were in calm waters. They identify Yonah as the source of their problem and he is cast overboard.

Chapter 2 commences with Yonah swallowed by a "great fish." Although this fish is generally assumed to be a huge aquatic creature, interestingly, it is not mentioned by the commentaries as one of the ta'ninim. On day 5 of creation, HaShem creates, among other creatures, the fish (Bereshis 1:20), including the aquatic creatures referred to as "ta'ninim" (Bereshis 1:21). Rashi interprets ta'ninim as (a) large fish within the oceans and (b) specifically, as the Leviathan. Rokeach suggests that these ta'ninim are large aquatic, fire-breathing serpents. Rav Dovid Brown [1] suggests they are sperm whales and Rav Aryeh Kaplan [2] suggests ta'ninim are whales, dragons, sea monsters, or the Leviathan and its mate. Why was Yonah's "great fish" not included in the category of the ta'ninim? Perhaps, this question bothered Rav Bachya, who interprets the phrase "great fish" as great in years, not size, as many aquatic creatures are much larger than this "great fish." This "great fish," was designated for the sole purpose of swallowing Yonah (Midrash Tanchuma, Va'yikra, 8), an assignment fulfilled over 3,100 years after its creation.

The identity of the species of fish that swallowed Yonah has received much speculation. Although the specific aquatic species cannot be identified, it is fair to question whether it was a whale, a large shark, or another type of fish. Some identify the "great fish" as the sperm whale (Physeter macrocephalus), as adult males reach a length of 50-60 feet. Sperm whales are carnivorous and eat giant squid, octopi, skates, and fish, including sharks. They are mammals and usually producing a single calf per gestation period (which is over 16 months!) [3]. According to Jewish tradition (e.g., Rashi on 2:1), initially, Yonah was swallowed by a male fish, in which he was comfortable and did not daven to HaShem. This male fish then transferred Yonah to a second female fish, pregnant with hundreds of thousands eggs, which made it uncomfortable for Yonah, thereby, prompting his prayers (Yalkut Shimoni). Thus, the aquatic creature that swallowed Yonah is identified as an oviparous (egg laying) fish, not an aquatic mammal.

What about a shark? Sharks tend to rip their prey, rather than swallow them whole. The Malbim notes that this specific aquatic species was commanded to swallow Yonah whole, rather than to tear him into pieces. Thus, the "great fish" could have been a species of shark that was specifically commanded not to rip and tear Yonah. However, this shark must be huge, as, according to the Radak and Pirke de Rabbi Eliezar, Yonah's entry into the "great fish" was compared to that of a person entering a great synagogue, with enough internal height permitting him to stand erect. The largest of the sharks is the whale shark, Rhincodon typus, which reaches a maximum length of 45 feet. The white shark feeds on microscopic plankton, larger free-

swimming prey, such as small crustaceans, schooling fish, and occasionally tuna and squid. Female white sharks are ovoviviparous (i.e., live-bearers). In the pregnant female, the eggs are housed in temporary shells from which the embryos hatch within the mother and nourished by a yolk sac and a secretion, known as "uterine milk." The female gives birth to live young. In 1995, an 11-meter female whale shark was harpooned and found to contain 300 fetal specimens [4, 5]. Interesting, Rav Moshe Alshich states that the second female fish was pregnant with thousands of small fish, not eggs - indicating the fish was ovoviviparous.

It is probably most prudent to conclude that the "great fish" remains an unidentified species, which may or may not be extinct. However, this specific fish has the distinction of being one of the three creations with whom HaShem directly communicated (Beehoros 8a).

As noted above, some commentaries (e.g., Rashi) suggest that Yonah's residence in the "great fish" involved two distinct fish, an initial male fish and then a female fish. However, others (Zohar, Beshallach 47b 48a; Rav Bachya) suggest that only one fish was involved. In this case, Yonah, feeling comfortable, did not pray during his 3-day stay in the fish's stomach. HaShem killed this fish and other fish fed on its carcass, causing discomfort to Yonah and prompting his prayers. HaShem then revived the fish. However, there is another possible explanation that involves only one fish, yet incorporates the concept of an initial male fish followed by a pregnant female fish. Some fish are hermaphroditic and exhibit behaviorally- and environmentally-induced adult sex change, which can involve males becoming females and females becoming males [6].

Once swallowed by the fish, Chazal question Yonah's ability to see in the dark interior of the fish's stomach. According to Rav Meir, a pearl suspended inside the fish provided illumination (Pirke d'Rabbi Eliezer, chapter 10). Rav Meir may have been referring to those luminescent minerals that release light energy. In the process of luminescence, an energy source kicks an electron of an atom out of its ground (lowest energy) state into an excited (higher-energy) state; the electron falls back to its ground state and gives back the energy in the form of light. There are several varieties of luminescence, each named according to the source of energy that triggers the luminescence. Yonah may have used a mineral that emits light by triboluminescence. In this mode of light emission, the minerals are luminous upon being hit, crushed, scratched, or rubbed; here mechanical energy is converted to light energy [7].

Another question focuses on Yonah's ability to survive inside the stomach of a fish. The diet of a fish capable of swallowing a human probably consists of large squid, octopi, and/or tons of smaller schooling fish. Once devoured, the fish's acidic digestive juices, which include proteolytic enzymes, decompose the ingested food. If so, how was Yonah able to survive in this digestive soup of extremely low pH? The Yalkut Shimoni (in chapter 4 of Yonah) suggests that the extreme acidity of the fish's digestive juices burned Yonah's clothes, jacket, and body hair. Again, so how was Yonah able to survive? A second question is directed to Yonah's sustenance inside the fish. Did Yonah eat the kosher fish (probably, as sushi) ingested by his host fish? These questions bothered Rashi (2:1), who suggests that HaShem took manna (i.e., the miraculous, spiritually-derived food that sustained B'nei Yisroel in the desert) and sustained the fish with it. Apparently, this spiritual food negated both the fish's need to swallow prey fish and its need to continue secreting acidic digestive juices. The internal environment of the fish's stomach was now suitable to allow Yonah to survive. Rashi also suggests that this manna served as a food source for Yonah. We know that eventually Yonah davens to HaShem from within the fish, yet, a person is not permitted to daven is an unsuitable place (e.g., bathroom). What about Yonah's defecation? How could he daven in an area contaminated with human feces? However, we know from the encounter of B'nei Yisroel with manna, that this spiritual food was completely absorbed into the body, without the production of metabolic waste.

Pirke d'Rabbi Eliezar relates an interesting event concerning Yonah's stay within the fish. Apparently, on that specific day the fish was designated for devouring by the giant Leviathan. As Yonah was still within the fish, his fate was tied to the fate of the fish. Yonah requested the fish take him to speak with the Leviathan. Upon encountering the Leviathan, Yonah related that in the future Messianic age, he would be assigned the task of slaying the Leviathan and preparing it for a feast for the righteous. Upon hearing this, the Leviathan fled in fear. As a reward for being saved, the fish gave Yonah an undersea tour, which included the pathway through the Red (Reed) Sea taken by B'nei Yisroel when leaving Egypt, the Eben Shethiyah (Foundation Stone), and an entrance to Gehinnom. As Yonah was within the fish and as the fish was transversing through underground aquifers lacking light, how was Yonah able to view these tourist attractions? This question bothered Rashi (2:6), who states that the fish's eyes were like windows lit by torches. Apparently, Rashi was referring to the bioluminescent bacteria living in the eye sockets of deep-dwelling fish. Bioluminescence is, in a sense, the opposite of photosynthesis. In photosyn-

thesis, green plants convert light (solar) energy into chemical energy (ATP), whereas in bioluminescence, the organism converts chemical energy (ATP) into light energy, as, for example, light emissions from fireflies. Sunlight can only penetrate the uppermost layers of the ocean; all visible light disappears below 100 meters. Fish dwelling in the great depths need an alternative light source. Bioluminescence is the solution. It is estimated that 90% of the deep-sea creatures are bioluminescent, employing a symbiotic relationship with bioluminescent bacteria, the actual producers of light. For example, the so-called "flashlight" fish house bioluminescent bacteria in small pouches under their eyes; by opening and closing these pouches, the fish use the bacterial light emissions to communicate with other fish and to attract mates [8]. These flashlight fish apparently are what Rashi meant when describing Yonah's fish as having eyes that are like windows lit by torches.

Rav Brown [1] questions how the fish was able to show Yonah the Eben Shethiyah (Foundation Stone), which is fixed in the depths beneath the Hachil of the Bais HaMikdash, as Mediterranean coast off Eretz Yisroel or, perhaps, at the northern most tip of the Gulf of Aqaba, is the closest that the fish could get to Yerushalayim. If so, how could Yonah have seen the Eben Shethiyah, beneath the Bais HaMikdash. Rav Brown, therefore, concludes that the Eben Shethiyah is not a small rock, but rather it is shaped as an underground mountain, spreading deep beneath the surface to underlie all of Eretz Yisroel and forms the continental shelf that Yonah reached (see page 322). However, as the Eben Shethiyah is the "plug" to the subterranean deep waters, another thought is that the fish approached the underside of the Eben Shethiyah by swimming in underground aquifers (Rav Reisman, personal communication).

Chapter 2 concludes with the fish spewing Yonah out to dry land. Pirke d'Rabbi Eliezar acknowledges that the fish's stomach, with its acidified digestive juices, was a hostile environment for Yonah. When spewed from the fish's mouth to dry land, Yonah's clothes were torn, his hair had fallen out, and his skin was shriveled and swollen because of his stay within the stomach of the fish.

Chapter 3 commences with HaShem coming to Yonah a second time and commanding him to go to Nineveh. Yonah, provided with a second opportunity to bring HaShem's message to Nineveh, tells the people and king of Nineveh that unless they repent, HaShem will destroy the city in 40 days. The people and their king (who, according to one opinion, was the same pharaoh from the time of Moshe) repent.

> As a reward for being saved, the fish gave Yonah an undersea tour, which included the pathway through the Red (Reed) Sea taken by B'nei Yisroel when leaving Egypt, the Eben Shethiyah (Foundation Stone), and an entrance to Gehinnom.

The last chapter begins with Yonah depressed and requesting to die. To view the outcome of his prophesy or, perhaps, to see if the repentance of Nineveh was sincere, Yonah lives in a handcrafted hut just outside the city. HaShem causes a plant (i.e., the kikayon) to grow unexpectedly, covering the open roof of the hut and providing shade for Yonah. He is quite pleased. However, HaShem designates a worm to attack the plant, causing it to wither. With the source of shade obliterated, the sun beats on Yonah's head and a hot wind arises, causing him to feel faint and, compounded by his overall depression, to request to die. The chapter ends with HaShem explaining to Yonah why He grants clemency to the Ninevites after their repentance.

There is discussion among the commentaries on the identification of the kikayon. Rashi describes it as a plant that grows high, has many long branches, and affords shade. The Ibn Ezra, quoting scholars from Spain, identifies it as the gourd and the Redak as the castor bean plant. The gourd (perhaps, the species, Lagenaria siseraria, or bottle gourd) is a climbing plant with large leaves [9] and the castor bean plant (Ricinus communis L.) grows 10-12 feet tall with gigantic, broad leaves. Seeds of the castor bean plant produce oil used in folk medicine remedies and are the source of ricin, a deadly poison used in bioterrorism [10]. As both plants produce very large leaves that would provide much shade, they are suitable candidates for the kikayon.

HaShem designates a worm to destroy the kikayon. The Me'am Loez and the Radak note that the worm attacks the roots of the plant, causing death and wilting of the aboveground leaves. Perhaps, this worm

was a nematode, or roundworm. More than 10,000 species of nematodes have been identified, with about 2,500 being parasitic to plants. Many plant parasitic nematodes attack the plant roots, causing aboveground pathologies, including wilting in hot weather. Most plant-parasitic nematodes range in length from 0.02 to 0.04 inches [11]; Rav Chaim Rabinowitz (in Daas Soferim) specifically mentions that this worm was very small and, therefore, could be a nematode. The kikayon has a short existence; it sprang up overnight and at the end of the following night, by daybreak, it withered (Ibn Ezra; Radak). Thus, HaShem's zoologic impact on Yonah ranged from a huge fish to a minute worm.

Yonah went to sleep a happy man, in his hut with the kikayon providing additional shade. However, when he awoke, the kikayon had withered and he was exposed to extreme heat, from the sun and from a strong, hot wind common in the Middle East (Rav Rabinowitz in Daas Soferim). "And it happened when the sun rose that HaShem designated a stifling east wind; the sun beat upon Yonah's head and he felt faint" (Yonah 4:8). A combination of forces interacts to discomfort Yonah. The commentaries note that HaShem designated an oppressively hot, eastern wind to blow, which also swept away the hut and what was left of the kikayon. Yonah was totally unprotected and could not endure the duality of the oppressive, hot wind and the sun beating on his head. He became faint, apparently experiencing heat stroke, which occurs when the normal body heat loss processes become ineffective and hyperthermia, or elevated body temperature, ensues. Symptoms of hyperthermia include an increased metabolic rate, which in turn, increases heat production by the body. The skin becomes hot and dry and, as the body temperature spirals upward, multiple organ damage, including that of the brain, becomes a possibility. Heat stroke can be fatal [12].

Albeit the wind was hot and oppressive and the sun was strong, but why was Yonah hypersensitive to these stresses? Hair on the scalp guards the head against physical trauma, heat loss, and sunlight [12]. The pasuk (4:8) specifically states that the sun beat on Yonah's bald head. The Midrash Tanchuma (Toldos, 12) notes that Yonah's scalp hair and facial beard were dissolved following his stay in the fish's stomach. The Ibn Ezra explains that because Yonah was in the stomach of the fish for an extended period of time his skin was tender and hypersensitive to heat. Rav Yosef Kara suggests that when the sailors threw Yonah into the sea, the high salinity caused his hair to fall out. Without hair covering his skin or head, Yonah was hypersensitive to the sun, explaining his fainting when the sun beat on his head.

This incident with Nineveh concludes Yonah's role as a navi. Apparently, sometimes a person must be hit with the "kitchen sink" before he understands the message. HaShem utilizes many components of naure - a great fish, a minute worm, the kikayon plant, a tempest, turbulent waves, strong winds, and the sun – to bring across His message to Yonah. ■

Dr. Harvey Babich is a Professor of Biology and Head of the Biology Department at Stern College for Women

Acknowledgements:
Appreciation is expressed to Rabbi Yisroel Reisman, Agudas Yisroel of Madison and Yeshiva and Mesivta Torah Vodaas, and to Rabbi Eli Babich, Jewish Enrichment Center and HAFTR, for reviewing this manuscript.

References:

[1] Brown, D. 1997. Mysteries of the Creation. Targum Press, Inc., Southfield, MI.
[2] Kaplan, A. 1981. The Living Torah. Maznaim Publ., Corp., NY, NY.
[3] Enchanted Learning. 2004. Sperm Whale, In http://www.enchanteedlearning.com/subjects/whales/species/Spermwhale.shtml
[4] Davis, D.F. 2004. Facts and stats about sharks, In http://www.mote.org/~rhueter/sharks/about_sharks.phtml
[5] Martins, C. and C. Knickle. 2004. White shark, In Ichthyology at the Florida Museum of Natural History. http://www.flmnh.ufl.edu/fish/Gallery/Descript/Whaleshark/whaleshark.html.
[6] Shapiro, D.Y. 1990. Sex-changing fish as a manipulable system for the study of the sex determination, differentiation, and stability of sex in vertebrates, J. Exp. Zool. 4(Supplement):132-136.
[7] Li, Z. 2004. Physical Properties, In GEOL Minerals and Rocks. http://uwp.edu/~li/geol200-01/phy_pro/index.htm
[8] Widder, E.A. 2003. Marine Bioluminescence, In Bioscience Explained, Vol. 1. http://www.bioscience-explained.org/EN1.1/PDF/BiolumEN.pdf

[9] University of Hawaii, 2004, Cucurbitaceae, In Flowering Plant Families. http://www.botany.hawaii.edu/faculty/carr/cucurbit.htm
[10] Duke, J.A. 1983. Ricinus communis L., In Handbook of Energy Crops, unpublished. http://www.hort.purdue.edu/newcrop/duke_energy/Ricinus_communis.html
[11] Ingham, R. and H.-J. Jensen 2003. Nematodes, In An Online Guide to Plant Disease Control. http://plant-disease.ippc.orst.edu/articles.cfm?article_id=1
[12] Marieb, E.N. 1997. Human Anatomy & Physiology, 4th edition. Benjamin/Cummings Science Publishing, Menlo Park, CA.

Translations used:
Rosenberg, A.J. (editor), 1991, Twelve Prophets, Volume 1, Judaica Press, NY
Zlotowitz, M., 1988, Yonah, Artscroll, Mesorah Publications, Ltd., Brooklyn, NY