The Science Behind Some Mishnaic and Talmudic Passages

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There is much science in the Mishnah and Talmud and, without a proper background in the physical and natural sciences, earth science, mathematics and astronomy, the best the reader can do is to quickly gloss over the passages without understanding the intended meaning. To elucidate challenging *halachic* issues, the sages of the Mishnah and Talmud were cognizant of the world around them, both through astute observations and experimentation. At times, the initial recognition of a specific medical event can be attributed to a Mishnah and/or the Talmud. For example, whereas circumcision resulting in neonatal death was known, the first written observation that it was maternally transmitted in families as a genetic disorder was recorded in Talmud Yevamos 64b (Reisman, 2014). As *halacha* is all encompassing, the Talmud contains a wealth of scientific information (see Bernstein, 1938; Rosner, 2000) awaiting awaits deeper explanations. This article is an attempt to delve into the *possible* science behind some Mishnaic and Talmudic passages.

Nyctalopia (Night blindness)

Nyctalopia (night blindness) is the inability to see well in dim light or at night. It is associated with an inability to quickly adapt to entering a poorly illuminated environment from leaving a well illuminated environment. In a section in the Talmud dealing with folklore remedies for human ailments, a potential aid to assist in night blindness is mentioned. A person experiencing night-blindness (Rashi) should bring a rope of animal hair and tie one end of the rope to one his legs and other end of the rope to the leg a dog (Gittin 69a). In essence, as noted by Goodman (1979), this may be the first recorded reference to the use of a seeing-eye dog.

Anosmia (Inability to smell odors)

The Talmud in Baba Basra (146a, b) related the following incident. Rav Yehuda, citing Rav, mentioned an incident in the Galilee involving a man who was informed that his betrothed (*erusin*) "wife" had an impaired sense of smell. If true, he intended to divorce her. He devised a plan. The scheme was as follows: he would hide a radish inside his garment, enter a ruin with her, and ask her a question related to detecting odors. By observing her response, he would ascertain whether she could detect odors. He said to her, 'I smell the scent of radish in the Galilee.' She responded, 'Who will give us of the dates of Jericho that I shall eat them,' indicating that she smelled dates (not, the radish that he brought with him). The story concludes with the roof collapsing, resulting in her death. There are other versions of this strange incident, all concerned with the woman's inability to detect odors.

The inability to detect one or more odors is termed anosmia ("smell blindness"). Anosmia maybe be genetic disordered (transmitted as an autosomal or X-linked dominant) (Goodman, 1979) or maybe environmental (*e.g.*, caused by inflammation of the nasal mucosa). The condition may be permanent or temporary (as, noted upon infection with COVID-19) (Wikipedia, n.d.).

If the woman lacked a sense of smell, why was this considered to be cause enough for a divorce? Apparently, olfactory disorders have been linked to a variety of significant psychosocial consequences, including depression, stress and anxiety, impairment of eating experience, and relationship difficulties (Philpott and Boak, 2014). Blomkvist and Hofer (2021) reported that olfactory impairment had negative effects on close romantic social relationships, including eating

behaviors, sexual behavior, and social functioning and support. Although there is evidence to suggest that anosmia may have a negative impact on a young couple establishing a close bond, his approach to the situation needed much refinement.

Fear and menstruation

The female monthly cycle of ovulation (the release of the egg from the ovary into the oviduct) and menstruation (expulsion of uterine tissue prepared to receive an embryo) is a complex physiological event involving multiple organs. Hormonal interactions between the hypothalamus (a portion of the brain), the anterior pituitary gland (located at the base of the brain) and the ovaries (locate in the lower abdominal cavity) regulate the female reproductive system; this interactive system is termed the hypothalamus-pituitary-ovary (HPO) axis. Communication among these organs is controlled by hormones and exhibits both positive and negative feedback mechanisms. In brief, the hypothalamus sends hormonal messages to the anterior pituitary gland, which in turn, sends hormonal messages to the ovary, causing the maturation and release of an egg into the oviduct. The ovary sends a hormonal message targeting the uterus to produce a highly vascularized bed, the endometrium, for implantation of an embryo. If the egg is not fertilized, there is no embryo to implant, and the endometrium is shed, the process is termed menstruation.

The HPO axis may be modified by stress, especially extreme chronic stress, which ignites the fight-or-flight response, *i.e*., the hypothalamus - anterior pituitary - adrenal gland (HPA) axis. In this scenario, the body's focus switches from reproduction to survival. Stress is detected by the brain, which signals the hypothalamus to send a message to the anterior pituitary gland, which sends a message to the adrenal gland to release the stress hormone, cortisol. Cortisol stimulates fat, carbohydrate, and protein metabolism, creating a surge of energy in the body and increases heart rate and breathing rate allowing more oxygen to be brought to muscles. Upon experiencing chronic stress, such as fear, the HPO axis may be turned off and the HPA axis turned on.

Apelian (1923) published his observation of the effect of fear on menstruation. Initially noting that the medical profession was knowledgeable that fear can suppress regular menstruation, he felt it important to mention his personal observations on the effect of war on menstruation. He wrote, "During the world war thousands of Armenian women were driven from their homes into the plains of Syria and Arabia, where they lived under a reign of terror. As the result of, and an uncertainty of the future, and anxiety for their killed beloveds, 80 percent, of mature women stopped menstruating, and some showed mental derangements. Of course, later on malaria and other anemic conditions raised this percentage. This condition lasted until the days of the armistice."

Not known to Apelian (1923), there is a much earlier published source for the effect of chronic fear on menstruation. A Mishnah in Niddah (4:7) discusses the case of a woman with a fixed period cycle. If the time for her period arrived and she did not examine herself, she is assumed to be *tamei* (ritually impure). Rabbi Meir said, If the case involves a woman who was in a hiding place and the time for her fixed period arrived and she did not examine herself, she is presumed to be *tahor* (ritually pure) because fear stops the discharge of menstrual blood. Rav (Talmud Niddah 16a) elucidated that the case in the Mishnah referred to a woman who was hiding in fear of bandits or an invading gentile army - exactly, the case recorded by Apelian (1923).

Aylonis

An *aylonis* is a female that by 20 years of age has still not showed sign of puberty, in that she lacks at least two pubic hairs (Niddah 47b). Other identifying signs of an *aylonis* include the lack of breasts, experiencing pain upon cohabitating, absence of a lower abdomen characteristic of females (Rashi: the lower torso does not bulge outward over the genital area), a masculine voice (Yevamos 80b), and underdeveloped internal female organs (Rambam, Hilchos Ishus 2:6). Her physiologic condition impacts marriage, divorce, *chalitzah*, and *yibum* (Gittin, 46b; Yevamos 12b).

There is a thought that an *aylonis* is a female with Turner syndrome, a genetic chromosomal disorder. All normal human beings contain 46 chromosomes in their somatic, or body, cells. A woman with Turner syndrome has somatic cells with only 45 chromosomes, lacking an additional X chromosome, which is typical of normal females (XX). This abnormality arises upon fertilization, when either the sperm or egg cell lacked an X chromosome, producing a zygote (*i.e*., fertilized egg) with 45 chromosomes.

Girls with Turner syndrome are often short, do not start puberty, lack ovaries or have malfunctioning ovaries, have an immature uterus, lack a menstrual cycle, lack breasts, and cannot bear children. These overt physical signs parallel those of an *alonyis*. Other complications of Turner syndrome include heart defects, diabetes, a low level of thyroid hormone, and a reduced life expectancy. Most women with Turner syndrome have normal intelligence. Turner syndrome occurs in one in 5,000 females at birth (Wikipedia, n.d.).

Cesarian section

The intent of this discussion is to correct an error in the medical literature on the history of a Cesarian section, which is a surgical procedure involving the incision of the abdominal wall and uterus of a pregnant female, whether an animal or a human, and extracting the fetus through the incision rather than allowing for a vaginal delivery. According to the medical literature, the first recorded case of a *successful* Cesarian section in a human, with "successful" defined as the case in which both the fetus and the woman survived, occurred in 1500 in Switzerland. Credit is given to Jacob Nufer, a Swiss sow-gelder, whose wife was in labor for several days and was unable to deliver the baby, despite the assistance of 13 midwives. Nufer, using a razor for the incision, delivered a healthy baby. The baby lived to the age of 77 years and his wife subsequently had five vaginal deliveries (O'Sullivan, 1990).

About a 1,500 years earlier Jews were successfully performing Cesarian sections on domesticated sheep, goats, and cattle and on humans, experiencing dangerously prolonged labor. *Yotze dofen* is the phrase in the Mishnah and in the Talmud to denote a Cesarian section. Jewish shepherds and cattlemen had expertise in performing Cesarian sections on pregnant domesticated animals, so that after extracting the viable lamb, kid, or calf, the dam remained viable and was capable of a later vaginal delivery (Mishnah Bechoros 2:9). The Talmud (Niddah 26a) discusses the case of a woman who gave birth to twins, the first, delivered vaginally, was deformed and nonviable, whereas the other twin, delivered by Cesarian section, was normal and viable. The question in the Talmud concerned the *halachic* requirement of the mother to bring a childbirth offering for the birth of the deformed, non-viable fetus. Implicit in this question is that the mother survived the operation.

This *halachic* issue was noted in Talmud Kereisos (7b), where the sages concluded, based upon that after a Cesarian section, the woman did not acquire childbirth *tumah*, did not observe the days of *taharah*, and was not required to bring a childbirth offering. This opinion was a point of disagreement between the sages and Rabbi Shimon (Mishnah Niddah 5:1). As the question was whether the woman was *halachically* required to bring an offering and to observe the days of *tumah* and *taharah*, obviously she survived the surgical procedure. As succinctly stated by Boss (1961), "Ante-mortem caesarian section, saving both mother and child, seems therefore to have been an accepted practice and not a fantastic exploit."

In the Mishnah Bechoros (2:9) and again in Talmud Niddah (40a; Rashi) a piece of information is added to the surgical procedure: the Cesarian section was performed by *sam*: "By a *sam* they opened the uterus; they bought the fetus out, and she healed." The definition of *sam* is obscure; possibly, it was a medication, an analgesic or a suave that promoted healing.

Brown (2019b) noted that when Mishnah Niddah "was edited around 200 B.C.E.; there were neither antibiotics nor anesthetics (at least in any modern sense) and there was no germ theory of disease. Postpartum maternal death following natural childbirth was common enough, but the rate of a woman surviving a Cesarian section must have been extremely low. Yet, here in the Mishnah teaching that a woman who recovers from this operation is exempt from bringing a sacrifice, which implies that surviving Cesarian section was an event so common that it required its own legal ruling."

Jews in the Mishnaic and Talmudic eras were not strangers to surgery, and surgical operations were performed. Talmud Bava Metzia (83b) notes Rabbi Eleazar was obese and underwent adiposectomy (excision of fat tissue). He was given a sleeping potion (an anesthetic), taken into a marble chamber (*i.e.*, the operating room), had his abdomen opened (laparotomy), and fat tissue was removed (Rosner, 2000). Perhaps more astounding is the case of cranial surgical noted in Talmud Kesuvos (77b) for the purpose of removing a type of growth or parasite resting on the meninges of the brain. The surgical protocol was as follows: (a) create a mixture/potion of pennyroyal and wormwood, to be used, perhaps, as an anesthetic or pain reducer; (b) choose the most appropriate operating room. A marble room where there was no draft was the first choice; if not available, then a house with thick walls was used. Apparently, although unbeknown to the surgical team, the prevention of a draft eliminated contamination by airborne microbes. (c) The mixture/potion was applied many times to the skull, following by (d) opening the skull. Although the instrument used was not mentioned, in Mishnah Ohelos (2:3) note was made of a *gimlet*, a tool used to make holes in the skull. Once the brain was exposed, the surgeon (e) identified and (f) disposed of the growth (Weinberg, 2006). Similar precautions may have been followed when performing Cesarian sections on woman experiencing dangerously prolonged labor.

Centuries later, after the finalizing of the Talmud, there is no mention of Jews performing Cesarian sections, possibly because of resistance by the Moslem and Christian host countries. Moslems absolutely prohibited a Cesarian section and a child born by this procedure would have been slain. In Christian Europe, the Jew practicing a Cesarian section was considered in league with the Devil, which would precipitate a bloody pogrom. The restrictions imposed upon Jewish communities either caused the Caesarian procedure to go underground or caused its transmission to be halted (Boss, 1961).

Rambam discussed a Cesarian section performed on a human and noted in Mishnah Bechoros (8:2): "One delivered by Cesarian section and the one following him - neither of them is a *bechor* in regard to inheritance nor in regard to redemption from a Kohen. Rabbi Shimon says: The first one is a *bechor* in regard to inheritance and the second one regarding the five *selaim*." Rambam understood this Mishnah as follows: "It may happen that this woman is pregnant with twins, and one comes forth after the side of the stomach is incised (*i.e*., a Cesarian section) and the later the other one comes forth by the ordinary route (*i.e*., a vaginal delivery), and the first one dies after the second one comes out. But what some say, that a woman can live after her side is cut open and then bear a child, is contrary to reason and is exceedingly absurd." It would appear the Rambam considered it medically impossible for a woman to survive a Cesarian section.

Rambam was much accomplished, a respected scholar and a respected physician, living in Egypt and serving the sultan. He authored, in Arabic, many treatises on medicine and health (see Rosner,1988). Yet, his analysis of this Mishnah had a basic medical flaw, there is a minute possibility for a pregnant woman carrying twins to undergo a Cesarian section to deliver the first baby and immediately thereafter to go into labor to produce a second child by a vaginal delivery. Lurie (2006) stated, "The situation of a Cesarean section where the first twin is delivered abdominally (through a cut in the uterus) and the second one vaginally is physiologically virtually impossible and also illogical because it is easier and safer to deliver both twins abdominally." Boss (1961) also commented on the weakness of the medical scenario presented by Rambam. As a rationalist and noted physician, Rambam would not have formulated an illogical medical event and afterwards note that it was absurd. Rambam's works were written in Arabic and, possibly, because of pressure from the dominant Moslem community, Rambam needed to conceal his true thoughts by presenting an impossible medical scenario, in which the pregnant woman could not survive the abdominal/uterine surgery. Jews, who are astute in Talmudic analyses, would have recognized the medical problem, especially as Rambam presented an analysis and concluded by stating "this is very strange." Rabbi Y. Kafich (1989) modified Rambam's interpretation of this Mishnah as follows: with the first pregnancy the baby was delivered by Cesarian section and, *at a later time*, there was a second pregnancy, and his baby was delivered vaginally.

The initial point of this section was to correct the medical history on a Cesarean section. The first recorded occurrence of a successful Cesarian section performed on a human, with both the woman and baby surviving, is noted in the Mishnah (Niddah 5:1). The story about Nufer and his wife is interesting, but not more than that. Rabbi Chrysler (2005) of the Kollel Iyun Daf Hadaf of Yerushalayim, regarding the Cesarian section, wrote: "It is not uncommon for the world to attribute newfound discoveries to the Gentile who discovers them in his day, even though we knew about them many centuries earlier."

Dorketi family (Androgen insensitivity syndrome)

The Talmud (Kesuvos 10b) relates the following incident. A man came to Rabban Gamliel and said to him: 'My teacher, I engaged in sexual intercourse and did not find blood. The bride said to him: My teacher, I am from the family of Dorketi, who have neither menstrual blood nor blood from the rupture of the hymen.' Rabban Gamliel

investigated her claim and discovered it to be true. He told the husband to be happy as his wife will never be a *safek niddah*. The Talmud explains that the meaning of Dorketi is a 'truncated generation' [*dor kato'a*]. Rabbi Hiyya explains that a woman who does not menstruate cannot bear children and Rabban Gamliel's congratulatory words were in vain. This idea is repeated in Talmud Niddah (40b) that Dorketi means a generation cut off from progeny. Goodman and Plato (1982) summarized Rav Hai Gaon, Rambam, and Bertinoro who all concurred that this woman was sterile.

Dissecting the information provided in the Talmud Kesuvos, several hints can be gleaned regarding the nature of the Dorketi syndrome. (a) It is a familial transmitted disorder, indicating a genetic component; (b) infertility occurs only in some of the females, and not in the male members of the family; (c) upon sexual intercourse there is no vaginal bleeding; and (d) these females do not menstruate. Goodman and Plato (1982) suggested that Dorketi woman suffered from androgen insensitivity syndrome (formerly termed, testicular feminization syndrome, or TFS), an X-linked recessive disorder.

A brief introduction to human embryology is required. Prior to day forty of fetal development, the fetus has a bipotential gonad, that can develop either into testes or ovaries, two sets of internal tubes, the Wolffian ducts which are the forerunners of the internal male reproductive structures (epididymis, vas deferens, seminal vesicles, and ejaculatory ducts) and the Mullerian ducts which are the forerunners of the internal female reproductive structures (oviducts, uterus, and upper portion of the vaginal canal); externally, the fetus is recognizably neither male nor female. If the fetus is a genetic male (XY), at day forty the gene, SRY, on the Y chromosome is activated and promotes the bipotential gonads to become the testes, which produce testosterone (an androgen hormone) and anti-Mullerian hormone. Testosterone stimulates the Wolffian ducts to develop into the internal male reproductive system and anti-Mullerian hormone prevents the Mullerian ducts from forming the internal female reproductive system. Testosterone is converted to dihydrotestosterone which induces the fetus to develop external male genitalia.

A gene on the X chromosome, *TFS*, encodes for chemical receptors that allow the body cells to detect and to respond to testosterone, while the recessive mutant non-functioning form of this gene, *tfm*, does not permit the body cells to detect and to respond to testosterone, although it is produced. A normal phenotypic male is designated $X^{TFS}Y$, whereas an individual designated $X^{tfs}Y$ carries the defective gene and develops as a phenotypic female. Why? If the somatic cells cannot detect and respond to testosterone, then the Wolffian ducts do not mature to form the internal male reproductive structure. The testes, also produce anti-Mullerian hormone, which the body detects, preventing the Mullerian ducts from forming internal female reproductive structures.

As testosterone cannot be detected, externally there are no *obvious* male structures, rather, instead, there is a small protuberance thought to be the clitoris (but, actually, is the male organ). Also, externally there is an invagination of the body, thought to be (but, is not) the lower portion of the vaginal canal. Internally, if the abdominal cavity was opened, one would find only undescended testis. At puberty, the adrenal glands produce the sex hormones, both testosterone and estrogen. Whereas the body of this person does not respond to testosterone, it can detect and respond to estrogen, which stimulates breast development and has an overall feminizing effect. Individuals with androgen insensitivity syndrome, although genotypic

males, $X^{tfs}Y$, are noted for their very attractive female appearance, luxuriant hair, smooth skin, and well-proportioned body. These phenotypic females cannot menstruate (as they lack a uterus), do not produce hymenal blood (as they lack a true vaginal canal), and are sterile (as they lack ovaries) (Goodman and Plato, 1982).

Perhaps, androgen insensitivity syndrome is the disorder affecting some of the Dorketi females, then the defective gene would be transmitted within the family as follows: a normal male ($X^{TFS}Y$) marries a normal female ($X^{TFS}X^{tfs}$), who is a carrier of the defective gene. Their potential offspring would be:

25% $X^{TFS}X^{TFS}$ (normal female)
25% $X^{TFS}X^{tfs}$ (normal female; carrier)
25% $X^{TFS}Y$ (normal male)
25% $X^{tfs}Y$ (a Dorketi 'phenotypic female')

The defective gene remains within the Dorketi family because the carrier woman, $X^{TFS}X^{tfs}$, is a healthy, fertile female.

The Dorketi person is a genotypic male but a phenotypic female. A case was presented before Rabbi Eliezer Waldenberg, *t"zal*, that, *possibly* was androgen insensitivity syndrome. The child had a female outer appearance but had internal undescended testes. The question was whether such testes can be excised, as later in life they may become malignant. He ruled that it was permitted to remove the testes, as the child was medically sterile. He further ruled that accordingly to *halacha*, the gender of a person is determined visually, by the outer appearance of the person. As external organs determine gender, this child was a *halachic* female (Cohen, 1999; Weitzman, 2009).

Animal hybrids

The concept of *kil'ayim*, as applied to animals, includes mating different species to create hybrids and using animals of different species to pull together a plough or a vehicle (Yavikra 19:19; Devarim 22:9-11). As no reason is provided for the prohibition of *kil'ayim*, it is considered a prohibition within the category of those commandments whose reasons are beyond man's ability to understand (Yoma 67b). Yet, Biblical scholars try to understand a rationale for these prohibitions. Rambam (Guide for the Perplexed 3:37) considered animal hybridization as a form of idol worship, S'forno (Bereishis 1:11) noted hybridization produced sterile progeny, and Ramban (Yayikra 19:19) espoused that hybridization denies that *HaShem* created a perfect world. Maharal (Be'er HaGolah 2:10) suggested that animal hybridization hinted at licentious sexual relationships and thus was comparable to illicit relationships (Twersky, 2016).

An animal hybrid is the offspring from a sexual mating between two distinct species. According to the Biological Species Concept, animals considered to be of different species cannot breed together or if they breed together, produce infertile or nonviable offspring or offspring with abnormal phenotypic traits. Deleterious hybrid traits, collectively termed hybrid incompatibility (HI), act as reproductive barriers in speciation, explaining why flocks/herds of hybrids are not known. As a hybrid contains chromosomes from each parent, HI arises from improper interactions between multiple genes (Johnson, 2010). Yet, the Biological Species Concept is not a hard-fixed rule, as there are exceptions. Lions and tigers hybridize to produce s fertile liger, which may mate with either of its parent species or with another liger (Colston-Nepali and Leigh, 2019),

The hybrid animals most discussed in the Talmud are the *koy* and the mule. The definition of a *koy* is not definitive, but one thought that it is the offspring of a male goat

(a domesticated animal; a *behema*) and a female gazelle (a wild animal; a *chayya*). Another thought is that it is *beriah bifnei atzmah* (a unique creation), perhaps, the *Ayal HaBar* (*i.e*., the wild ram), for which there was uncertainty if it is a wild or a domestic animal (Chulin 80a, b). *Koy* were not common and there are no herds/flocks of *koy* (Aleph Society, 2015). Rather, it is mentioned in numerous gemoras to serve as the test case for discussions of the *halachot* of kosher hybrid animals. Thus, the precise zoologic identity of the *koy* was not of importance, rather that it is the offspring of different *halachic* types of kosher animal species and therefore trigger many questions. For example, there is a type of fat (*chelev*) forbidden to eat from a domesticated animal but permitted if it was from a wild animal. A pertinent question would be: does consumption of *chelev* from a *koy* obligate the person to bring an *asham taluy* (a provisional guilt offering)? (Kerisos 17a, b).

The mule is the hybrid offspring from the mating of a female horse with a male donkey. Mules were desired as they exhibit "hybrid vigor," defined as when the hybrid exhibits a trait more superior than either parent. Mules are as intelligent as horses and are more patient, hardier, and longer-lived than horses; mules are more intelligent than donkeys, are perceived as less obstinate than donkeys, and can successfully handle rougher terrain than donkeys and, therefore, are valued as pack animals. However, mules are sterile and cannot breed. Horses have 64 chromosomes, donkeys have 62 chromosomes, and mules have 63 chromosomes. Sterility may be for several reasons, such as the failure to produce viable oocytes and sperm cells, thus effectively blocking normal estrous cycles, sperm cell development, and fertilization (Wikipedia, n.d.). Yet, fertility has been noted in some mules. This was previously noted in the Talmud (Kesuvos 111b): "Regarding a female mule that indicated a desire to mate, one may not mate her with a horse or a donkey, but rather, one may mate her only with her own kind - a male mule.

Recently there have been documented reports of mules mating and producing foals. Most probably, more mules than realized are fertile, but there are few attempts to breed mules. Most mule owners castrate male mules and spay female mules to remove their ovaries, in hopes of their changing behavior associated with estrus or aggression (Extension Horses.org, 2019; NPR 2007).

The possibility of fertile mules raised a question in Talmud Chulin (79a) of whether one *halachically* was allowed to breed mules. Is a mule itself viewed as two distinct species, so that breeding two mules may entail crossing the maternal side of the male offspring (derived from a horse) with the maternal side of the female offspring (derived from the donkey)? If so, that would be forbidden. However, *Chazal* viewed a mule as a distinct new species, not an organism that is part horse and part donkey. Biologically this is correct, as each somatic cell in a mule contains half the number of its chromosomes from a horse and the other half of its chromosomes are from a donkey. There are no somatic cells in a mule that contain only donkey chromosomes or only horse chromosomes. As a distinct species, mules may be bred because both the male mule and female mule have the same number and kind of chromosomes in the somatic cells.

Talmud Pesachim (54a) notes an interesting incident regarding the origin of mules. Bereishis (chapter 36) lists the sons of Seir the Chori. Seir had many offspring, including Tzivon, the father of two sons, Alah and Anah. Mention is made that Anah discovered mules (*yemim*) in the desert while pasturing his father's donkeys (Bereishis 36:24). Apparently, the Torah is telling us something about Anah and mules. Rashi, citing Pesachim

(54a) notes that Anah was a momzer, as his father was Tzivon (a son of Seir) and his mother was Seir's wife, *i.e*., Anah was both the son and brother of Tzivon. Apparently, Anah, himself born from an incestuous union, experimented by mating horses with donkeys, producing mules, also offspring from a forbidden union.

The *halachic* questions in Chulin 79 of the status of a hybrid animal would be applicable to a chimera, such as the geep. A sheep, with 54 chromosomes per cell, and a goat, with 60 chromosomes per cell (Long, 1990), can mate to produce hybrid offspring containing 57 chromosomes per cell. In the laboratory, scientists fused a sheep embryo with a goat embryo to create a geep. A geep is a chimera, not a hybrid, as it has distinct sheep cells (with 54 chromosomes) and distinct goat cells (with 60 chromosomes). Thus, for example the hide of a geep is a mosaic of sheep cells, producing wool, and goat cells, producing hair. A geep (fig. 1) would be the quintessence of *kil'ayin*.

Figure 1. A geep

The concept of crossbreeding species to create hybrids is noted in the Talmud, with mules used as the representative animal. According to Rav Nechemyah, the first mule was created by *HaShem* at "*bein ha'shemashos*," on the first *eruv Shabbos* of Creation (Pesachim 54a, b). Rashi added that this prototype of a hybrid animal was not created by crossbreeding a horse with a donkey, but rather was created from earth. However, further on that daf a Baraisa is brought that *HaShem* brought to Adom a horse and a donkey, crossbred them, and produced a mule. Rav Nechemyah added that fire was also created by *HaShem* at *"bein ha'shemashos." HaShem* gave Adom the understanding that rubbing and grinding two stones together produced sparks, which could be used to create fire.

Apparently, there is something to be learned from this information. If fire is representative of the physical sciences and mules are representative of the natural sciences, perhaps, *HaShem* was giving mankind creative ability, *i.e*., the "*da'as*," to manipulate the world by taking what exists and improving upon it (Sefas Emes). Thus, fire as a form of thermal energy may be alluding to mankind's development of other forms of energy, *e.g.*, nuclear energy. The crossbreeding of a horse and a donkey to produce a mule is a Biblical prohibition, yet, *in vitro* fertilization of a horse egg with sperm of a donkey would not be prohibited as there is no sexual contact between the two species. Or, during the *sh'mitah* year in Israel, growing vegetables by hydroponics would be permitted. The above examples are but a few of man's ingenuity, applied within the framework of *halacha*, to improve the world we live in.

The Mishnaic and Talmudic passages presented illustrate the deep understanding Chazal had of the natural sciences, often elucidating ideas and concepts centuries before their discovery by modern scientists.

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