

# Talmud Chullin: Some science behind the text

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Every tractate in the Talmud has its own flavor, its own essence, and its own soul. The secular background needed to fully comprehend a tractate will depend on the overriding theme of that tractate. For example, one tractate may require a background in astronomy, a second may require a business mind, and yet a third tractate may require knowledge of mathematics. Without having the appropriate background, the *talmid* will just be reading words. This does not mean that the *talmid* should give up, but it just is a reality of the situation. Chullin is a tractate for which a solid background in zoology, veterinary science, and human physiology would be an asset. The intent of this article is to elucidate a few scientific topics or statements noted in Chullin, with the intent of making those aspects a bit more understandable or interesting.

## Fainting

In Chullin (3b) note was made that a proficient slaughterer of animals must not be squeamish upon seeing blood, as by fainting he may bungle the *shechitah*. A person is considered proficient when he slaughtered successfully two or three times and did not faint.

Physiologically, what is fainting? Fainting (or, syncope) is the sudden loss of consciousness resulting from a lack of blood flow to the brain. The anxiety or fear of seeing blood may cause an increase in heart rate and blood pressure, which is then followed by a sudden drop in blood pressure and pulse rate. The lesser flow of blood to the brain reduces the transmission of vagus nerve impulses to the musculature, resulting in a loss of muscle tone and causing the body to collapse under the pull of gravity. Once the person goes from an upright to a supine position, blood starts flowing to the brain and the person awakens. This phenomenon is termed “blood-injury phobia.” Symptoms prior to fainting include lightheadedness, nausea, sweating, inability to articulate words easily, weakness, and tunnel vision [1]. It is understandable that such pre-fainting symptoms will lead to bungling the *shechitah*.

Fainting upon the sight of blood is not a universal event, with only about 15% of Americans

experiencing a plunge in blood pressure causing one to faint upon seeing blood. Exactly “why” some people faint upon the sight of blood is not known, but it is believed to have a genetic component with an ancient mechanism driving it. Supposedly, there is an ancient “fainting gene” that confers a survival advantage. During battle, warriors who fainted and appeared dead were passed over. The sudden drop in blood pressure drop may have helped the wounded to avoid bleeding to death and facilitated blood clotting. Such survivors then transmitted the “fainting gene” to their descendents [2-4].

## Strange diets

In discussing *HaShem's* relationship with the non-Jewish world, mention was made of thirty commandments that the Noahites initially accepted upon themselves within the framework of the seven basic concepts of the Noahite Code. However, in actuality they only keep three of the thirty, one of which was that they did not weigh and sell meat of a human corpse in open markets. Apparently, they were “refined” cannibals who neither sold human flesh in the meat markets nor ate human flesh in public (Rashi, Chullin 92b).

Cannibalism had an impact on Jewish history. The story of Menasheh, a king of Israel who reigned for 55 years over Jerusalem, is mentioned in the third chapter in *Devrei HaYamin* II. He “did evil in *HaShem's* sight” and brought various abominations and idolatrous practices into the land of Israel. As a punishment, *HaShem* brought the Assyrian army against Menasheh, who subsequently was captured and led away in chains. The Talmud Yerushalmi, Sanhedrin (10:9) elaborates on the next events. Apparently captured by cannibals, once in enemy territory, Menasheh was placed into a large copper cauldron, with a fire lit beneath it. Realizing his precarious situation, Menasheh prayed to all the various gods he worshiped, but to no avail. Finally, remembering his Jewish heritage, he prayed to *HaShem* and was saved.

Another culinary delight is animal placenta. A Mishnah (Chullin 77a) discussed the case in which

one slaughtered an animal and found a placenta in its womb. If the person had a *nefesh hayafa*, *i.e.*, “a hearty soul,” and was not repulsed by it, he was permitted to consume it. Nonetheless, today most people do not consider an animal’s placenta as a food item (*i.e.*, it is not served even at a fancy *simcha*).

A current trend is for a birthing woman to request her placenta for later consumption (human placentophagy). The consumption of one’s placenta is thought to confer several (scientifically unproven) health benefits, including to enhance milk supply, to lower the incidence of postpartum depression, to increase energy, to ward off anemia, and to level off hormones [5].

Rabbi Aryeh Lebowitz [6] produced an audio *shiyur* of a woman who inquired the *halachos* of consuming her placenta. Discussed, amongst a variety of *halachic* responses, was whether consumption of one’s placenta was cannibalism, which it was not. Near the conclusion of the *shiyur* Rabbi Lebowitz noted that consumption of one’s placenta was reminiscent of the curse in *parshas Ki Savo* (Devarim 28:33), “You will eat the fruit of your womb - the flesh of yours sons and daughters, which *HaShem*, your G-d has given you - in the siege and distress that your enemy will distress you.”

Another unusual food item is the blood of kosher animals and fowl. Apparently, long ago, there was a strong desire to eat the blood from a slaughtered animal. Ramban (Devarim 12:22) explained that the desire to consume animal blood arose when the Hebrew tribes were slaves in Egypt. The people slaughtered animals to demons; the ritual included consuming the meat and blood of the sacrificed animal. The purpose of this ritual was to have the demons divulge future events. Thus, it was necessary for the Torah to state, “Only be strong not to eat the blood - for the blood is the soul - and you shall not eat the soul with the meat” (Devarim 12:23). Apparently, the Torah needed to stress “be strong,” as eating blood was ingrained in the populace (Rashi). Today, a Jew with an overwhelming desire to consume blood is directed to the liver, an animal organ saturated with blood. As Yalta, the wife of Rav Nachman, said, “Whatever the Merciful One forbade us, He permitted us something corresponding. He forbade blood. But permitted us liver” (Chullin 109b). The typical *kashering* preparation for liver is a bit more

complicated than for other types of animal meats, as it is designed to extract as much blood as possible and requires moderate salting followed by *kashering* by broiling.

The Torah prohibited consumption of animal blood in all its forms: whole blood (Chullin 35b), blood serum (Chullin 87b), *i.e.*, whole blood without the three basic cell types (red blood cells, white blood cells, and platelets), blood diluted with rainwater (Chullin, 87b), and solidified blood (Chullin 120a).

Before the Flood mankind was forbidden to eat the flesh of any animal. Only after the Flood was permission given to consume the flesh of animals, but with a limitation, “But do not eat flesh with its life force - its blood (Bereshis 9:4). Yet, in the non-Jewish world, animal blood is an ingredient in various culinary delights in European countries. Blood pudding/sausage, which almost always centers on pig’s blood, is part of the traditional Irish or Scottish breakfast. Other European countries have their own version of this sausage. Some, like the German *blutwurst* or the Spanish *morcilla* are stuffed with other cured meats, onions, or potato, as well as blood and grain. The blood of almost any kind of animal is used; livestock like sheep, goat, and cow are the most common, but duck and chicken can be used, too [7]. The Italian desert pudding, *sanguinaccio dolce*, uses blood of a freshly killed pig [8]. For those cultures who consume animal blood it is not such a far leap in thought to extend this to human blood, thereby possibly serving as the basis for the blood libel against the Jewish communities in Europe. Conversely, Jews, who are far removed from the consumption of animal blood in meats and fowl, the concept of consuming human blood is unthinkable. In fact, any meat that a Jew consumed has been soaked and salted within three days of the slaughter. This process, termed *kashering*, draws out the blood from the interior of the meat. The Jewish and non-Jewish concepts of consuming animal blood are at opposite ends of the culinary spectrum.

### **Head trauma and male infertility**

The following occurrence is mentioned in Chullin (45b): “Levi was sitting in the bathhouse and saw a certain man who smashed his head into the wall. Whereupon Levi exclaimed: The brain of this fellow has lost substance (*i.e.*, Rashi, the man experienced a brain concussion). Did he not mean to say that the

fellow would not survive? ' Abaye said, No, Levi meant to say that the fellow would not be able to father children.” Abaye concluded that such trauma to the brain would make the fellow sterile. Rashi commented that the reproductive ability of a man stems from the brain. Apparently, Rashi was referring to the hypothalamus-pituitary gland-gonad (HPG) axis, which will be explained shortly. The topic of traumatic brain injury (commonly termed, a brain concussion) as related to sports injuries, especially those of contact sports, and to injured soldiers is well documented to cause of male reproductive issues [9]. Located within the forebrain, the hypothalamus is a pearl-sized structure with many important physiological functions. Blood vessel connections between the hypothalamus and the pituitary gland, located at the base of the brain, allow for a pathway for hypothalamic hormones to travel to the pituitary gland. Of importance to fertility is the secretion of gonadotropin-releasing hormone (GnRH) from the hypothalamus to stimulate the anterior pituitary gland to release luteinizing hormone (LH) and follicle-stimulating hormone (FSH), which, in turn, stimulate Leydig and Sertoli cells, respectively, within the testes. Sertoli cells release androgen-binding protein which is necessary for spermatogenesis and Leydig cells release testosterone, which plays a key role in development of the male reproductive system and in stimulating male secondary sexual characteristics (Figure 1).

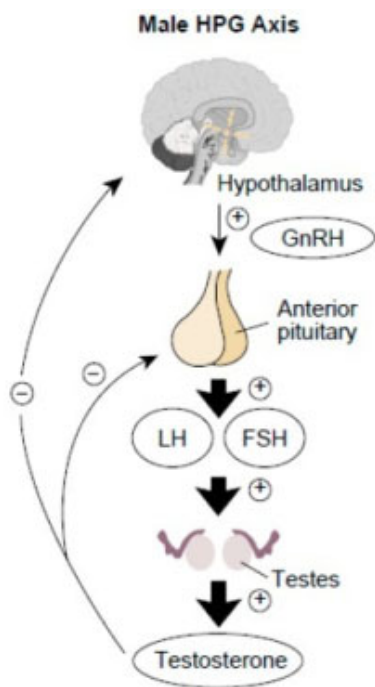


Figure 1. HPG axis

Disruption of the HPG axis may lead to impaired reproductive ability in the male [9]. Traumatic brain injury, as reported in cases of sports-related injuries, induces suppression of the HPG axis, as manifested in decreased libido, impotence (erectile dysfunction), hypopituitarism (a deficiency of pituitary hormones), hypogonadism (insufficient production of testosterone or impaired ability to produce sperm, or both), and infertility [9].

### Bone Marrow

Abaye and R' Yochanan (Chullin 125a) concurred that marrow inside a human bone regenerates flesh outside of the bone. Marrow is a sponge-like tissue found mainly inside large bones like the breastbone, pelvis, ribs, and spine. Within red bone marrow are hematopoietic stem cells which undergo asymmetrical cell division, producing another pluripotent stem cell and progenitor cells, which differentiate into red blood cells, white blood cells, and platelets. These cells, produced within bone marrow, eventually squeeze through pores in bone tissue and enter into the circulatory system (Figure 2).

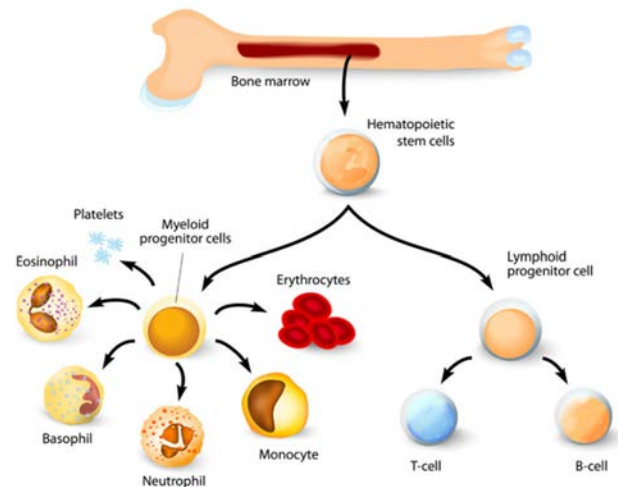


Figure 2. Differentiation of hematopoietic stem cells to different cell types found in blood.

In addition, relatively new findings from studies of bone marrow transplantations noted that hematopoietic stem cells apparently have a mind of their own and, in addition to differentiating into blood cells, were able to differentiate into buccal epithelial cells [10], hair follicles [11], and cells of fingernails [12]. This was described as “stem cell plasticity phenomenon” [13], *i.e.*, the ability of adult stem cells to cross lineage barrier and differentiate

into cells outside their own tissue. Abaye and R' Yochanan were perceptive in recognizing that marrow within bones was a living substance, which produced diverse cell types whose function was outside bones.

### Blood disorders

A *Baraisa* in Chullin (47b) noted that R' Nassan was in a city overseas when a woman approached him with her newborn baby to ask a question regarding circumcision. Apparently, her first and second newborn sons died upon being circumcised and she questioned about circumcising her third newborn son. As the newborn appeared red in color, he advised her to wait until the excessive surface blood was absorbed into the newborn. She followed his advice and the child survived circumcision. R' Nassan visited another city. A woman, whose two newborn sons died at circumcision, sought guidance about circumcising her third newborn, whose body color was *yarok*. R' Nassan diagnosed the problem that the blood system did not develop sufficiently. He advised her to delay the circumcision until the circulatory system fully developed. She waited and the circumcision was successful. Rashi defined *yarok* "like the color of grasses." Tosafos noted that *yarok* can refer to green, yellow, or a bluish hue of green. Attempts have been made to identify the specific blood disorders suffered by these babies.

Remembering that the Talmud is not a medical textbook, one needs to focus on the clues that were offered. First, as each newborn had two siblings who died at circumcision, it would appear, at first glance, that the blood disorder was genetic. Second, the skin color of the newborn was the key factor in the diagnosis. Third, the Talmud did not specifically note a problem with blood clotting. Rabbi Adin Even-Israel Steinsaltz [14], citing others, suggested that the reddish baby suffered from neonatorum purpura, a purplish or brownish red skin discoloration easily visible through the epidermis of the neonate. It is a hemorrhagic disease characterized by the escape of blood from the blood vessels; this disease may be accompanied by a low level of platelets, which are needed for blood clotting [15]. Dr. J. Brown [16], recently reviewed this topic, and cited J.L.

Katzenelsohn who postulated the disease as erythema (toxicum) neonatorum, which is a common rash in neonates appearing in up to half of newborns carried to term. The rash emerges between day 2-5

after birth. Some neonates are more sensitive than others and develop erythematous spots all over the body. The rash is thought to be due to an immune reaction, although clotting is sometimes suspected, but the connection remains unproven [17]. The most straight answer, given by Dr. Abraham Abraham (Nishmas Avraham, Yoreh Da'ah 263:3), is "I have no idea to what the rabbis are referring to" [cited in 16].

For the second case, the diagnosis is dependent upon the specific skin color of the neonate. If the infant was yellowish in color, then the diagnosis may be neonatal jaundice (Katzenelsohn cited in #16). The yellowing of the baby's skin is due to the breakdown of hemoglobin of fetal red blood cells, yielding the yellow pigment, bilirubin. Most cases of neonatal jaundice occur without complications [18]. A green tinge to the skin of the neonate may be due to hemolytic jaundice, characterized by periods of excessive hemolysis due to the unusual fragility of the red blood cells, which appear small and spheroidal [14]. A bluish skin (termed, cyanosis) usually is indicative of the lack of sufficient oxygen reaching the tissues. This condition may involve issues with blood vessels, the heart, or the lungs [16].

Lastly, it was suggested that *yarok* means pale, with the pathology being a lack of hemoglobin, possibly anemia [19]. A neonate with a deficiency in vitamin K appears pale. Vitamin K is responsible for the synthesis of prothrombin, a chemical important in blood clotting and produced in the liver. Babies are born with low levels of vitamin K and are at risk for vitamin K deficiency. However, on the 5th through the 7th day of a newborn's life as he/she is being breastfed, vitamin K is produced in increasing quantities by bacteria in the gut. Vitamin K, together with prothrombin produced by the gradually maturing liver, promotes blood coagulation. A vitamin K deficiency could lead to hemorrhaging [20]. Thus, there is a possibility that the neonate born with pale skin may represent a case of vitamin K deficiency. Furthermore, if this family had subsisted on a vitamin K-poor diet, this - not genetics - would explain the death at circumcision of the two prior brothers.

The *halachic* responses to these two cases in Chullin

were in sharp contrast to those recorded in Yevamos (64b). In Yevamos, a woman whose first two sons died upon circumcision was advised by Rabbi not to circumcise her third son. Rabbi Shimon ben Gamliel disagreed and suggested that she should indeed circumcise her third child, but if he died, she must not circumcise her fourth son. Other examples were presented in Yevamos with the genetic aspects of the bleeding disease clearly emphasized, with transmission through the female. Rabbi Yochanan said that there was once a case in Zippori in which four sisters had sons. The first sister circumcised her son and he died, the second sister circumcised her son and he died, the third sister circumcised her son and he died, and the fourth sister came to Rabbi Shimon ben Gamliel and he told her "you must not circumcise your son." These cases indicated that transmission of the blood disease was through the mother. Additional cases of newborns dying during circumcision were presented and the conclusion was that in all these cases the blood of the newborn was "thin," *i.e.*, it did not clot (Yevamos 64b).

The commonality between the circumcision incidents in Yevamos and those in Chullin was that the newborns had a blood disorder. The major difference was that in Yevamos the lack of blood clotting was emphasized, whereas in Chullin the color of the newborns was the deciding factor. Apparently, the cases in Yevamos and Chullin refer to different blood disorders, with the cases Yevamos being illustrative of the more serious pathologies. The bleeding diseases in Yevamos are thought to be representative of newborns either with hemophilia A (a deficiency in clotting factor VIII) or with hemophilia B (a deficiency in clotting factor IX), both X-linked genetic pathologies [21, 22]. In the era of the Talmud it was considered lethal and circumcision was avoided throughout life.

### **Wolf clawing**

There appears to be a discrepancy between Chullin (42a) and Arachin (15b) regarding the mode by which a wolf kills its prey. In Talmud Arachin (15b) it stated, "A lion claws its prey and eats it while still alive; a wolf tears its prey with its teeth, killing it and then eating it." In Chullin (52b), it stated that both a lion and wolf attack their prey by clawing, which injects a poisonous venom into the victim. Only a healthy kosher animal is suitable for consumption. The first Mishna of the third chapter in Chullin (42a) enumerated 18 physical fatal defects

that would render an animal *tereifah*. One such fatal defect is an animal that was clawed by a wolf or a lion. Rav Yehuha said, "One clawed by a wolf is rendered a *tereifah* in the case of small species (*i.e.*, goats and sheep) but not in the case of large (*e.g.*, bovine) species, but if clawed by a lion, it is rendered *tereifah* even in the case of large animals." Rashi explained that through clawing, the wolf or lion injected poison into the prey, which penetrated the flesh and burned a hole in prey's flesh. To be fatal (Chullin 53b), the clawing must be nearby a life-sustaining internal organ. Apparently, the amount of venom released by a wolf, as compared to a lion, was insufficient to be fatal to a large animal (*e.g.*, a bovine) but was sufficient to be lethal to a small animal (*i.e.*, a goat or a sheep).

This seemingly innocuous Talmudic statement triggered several potential difficulties [23, 24]: (a) Are wolves really that much smaller than lions, forcing the Talmud to note that a wolf attack on a small domesticated animal is fatal but not on a large domesticated animal? Observations of wolf packs in the wild clearly show that they attack large prey. (b) Clawing does not inject venom into the prey, as there are no poison glands near the claws, neither in a wolf nor in a lion? (c) Wolves attack their prey by using their teeth to tear the prey and do not attack by clawing, as does a lion. As stated in Arachin (15b), "A lion claws its prey and eats it while still alive; a wolf tears its prey with its teeth, killing it and then eating it." If so, why did the Talmud in Chullin need to mention a wolf mauls by clawing its prey? To tackle these difficulties, we need to clarify point-by-point: Apparently, our perception of the size of a wolf is based upon the species of wolf common in North America and Europe, *i.e.*, the gray or timber wolf. Adult gray wolves are 4 to 6.6 feet long and weigh from 40 to 175 pounds; females are much smaller than males [25]. Lions are larger than wolves. African male lions range from 330 to 575 pounds and are 8.5 to 11.5 feet long (including the tail); female lions are between 254 and 400 pounds and are 6.6 to 9.2 feet long including the tail [26]. North American/European wolves are smaller than African lions, yet such wolves are not small animals and they do prey upon large hoofed animals, such as deer, elk, bison, moose, and caribou [27]. If so, why did the Talmud note that a wolf mauling only of a small animal was fatal, rendering it a *tereifah*? As noted by Rabbi Slifkin [24], the species of wolf inhabiting the Middle East is

physically small, with an average weight of 50 pounds and length from 3.4 to 4.9 feet. Middle Eastern wolves avoid large prey, as a one kick from a large cow could disembowel the wolf. Difficulty one, answered.

The second difficulty is that today we know that clawing of a wolf or lion does not inject poison into the prey; there are no poison glands at the base of the claws of these animals. To solve this difficulty most cite R' Aryeh Carmel, in a footnote in *Michtav M'Eliyahu* (volume 4, letter 31, note 4), explaining that the claws of predators usually have flesh from prior prey lodged within their claws. Such flesh undergoes bacterial decomposition, producing metabolic end-products that are highly infective and toxic. Clawing would thereby inoculate infective bacteria into the flesh of the prey, and if the clawing was proximate to a life-sustaining internal organ, disease and death would ensue. The scientific community in the era of the Talmud was unaware of bacteria and of the concept of bacteria as the causative agents of infection and disease; the world would need to wait until the 19<sup>th</sup> century for the germ theory of disease to be formulated by Louis Pasteur and Robert Koch. Difficulty two, solved.

The third point to discuss is clawing as a mode of attack by wolves, especially, as the Talmud in *Arachin* (15b) noted that a wolf kills prey with its teeth. Indeed, wolves and lions have different modes of attacking prey. A lion is an ambush predator, using strong musculature of the front limbs and retractable claws to seize the prey, enabling it to make a lethal bite. Wolves lack retractable claws, hunt in packs, and rely on their jaws to subdue their prey. A pack of wolves may hunt the prey over long distances, tiring it out, and then mobbing the prey in coordinated bite-and-jump attacks. Biting the hamstrings and crippling the prey, the worn-out bleeding animal collapses to exhaustion [27]. Why did the Talmud in *Chullin* note that wolf clawing was potentially fatal, as a wolf attacks with its teeth? Apparently, a wolf has an extra toe, termed the dewclaw, on its hind legs (Figure 3). As opposed to the other digits, the dewclaw is sharp, not blunt, and can be rotated and used for gripping or ripping prey [28]. A wolf's dewclaws can be filled with bacterial-laden rotting flesh from a prior kill; such dewclaws may be the source of the wolf's lethal mauling as mentioned in *Chullin* (42a).



Figure 3. Dewclaw of a wolf

The clawing of a wolf, at the most, involves two dewclaws, whose purpose is not to maul the prey, but rather to hold and stabilize it. The amount of decaying flesh within a wolf's dewclaw probably is limited, perhaps, sufficient only to be fatal to a small, but not to a big, animal. Conversely, the main function of a lion's sharp, ultra-strong claws is to grab the prey and dig into its flesh. The claws are meant to grip and hold the prey, piercing through skin and muscle for a tight hold. A lion has five claws on the front and four in the back - the extra front claw (dewclaw) grasps prey from a different angle from the others claws, helping the lion hold on strongly. If these 8-10 claws are heavily contaminated with decaying flesh from a prior kill, it is understandable that such clawing would be fatal to large animals. Difficulty three, answered.

### **Severed tail of a lizard**

The Talmud (*Chullin* 21a) mentioned that geckos, a species of a lizard, were capable of severing their tail, with the excised tails jerking and lashing after removal from the body. This passage highlighted a unique survival mode, designed by *HaShem*, to allow a lizard to escape from a predator. This defense mechanism, termed "autotomy," is a process whereby, when threatened by a predator, the lizard can voluntarily shed its tail, which then serves as a decoy for predators. Tails are often brightly colored and their thrashing, lunging, and jerking movements on the ground draw attention of the predator to the moving tail and away from the lizard. This visual diversion allowed the lizard to escape. Nervous impulses responsible for movements of the shed tail begin at the very far end of the tail, in a portion of the spinal cord. This indicates that there is a control center located at the end of tail that is overridden by higher centers until the tail is severed, at which point its movement potential is actualized. The tail, in turn,



may rely on sensory feedback from the environment, mediating it to jump, pivot, or move in a specific direction [29].

Lizards that can sever their tails have “fracture planes,” between or in the middle of each vertebra, regularly spaced down the length of their tail. It is at these points that severing can occur. Skin, muscles, blood supply, nerves, and bone separate when the tail is severed and falls on the ground. Although beneficial for survival, the loss of a tail comes at a cost, as tails are important for jumping, climbing, and maintaining a sense of balance. However, over time, the lizard will regenerate another tail [29].

### Hybrids - mule/hinny

*Kil'ayim* refer to the prohibitions in *halacha* of a mixture, such as crossbreeding animals and working a team of different kinds of animals together., as noted in Vayikra (19:19), “You shall keep My statutes. You shall not let your cattle mate with a diverse kind ..” One such type of *kil'ayim* includes crossbreeding a horse with a donkey. Mating a male horse and a female donkey yields a mule and a male donkey and a female horse yields hinny. A horse (*Equus caballus*) and a donkey (*Equus asinus*) are different species, with a horse having 64 chromosomes in its somatic cells and a donkey having 62 chromosomes. If a horse and donkey mate, at fertilization the fusion of a horse gamete with its 32 chromosomes and a donkey gamete with its 31 chromosomes yields a zygote, to become either a mule or hinny (*Equus mulus*) with 63 chromosomes. The different structures and number of horse and donkey chromosomes prevent adequate pairing of chromosomes during prophase of meiosis I of gametogenesis; as a result most mules and hinnies are infertile [30].

The Talmud (Chullin 79a) noted differences between the phenotype of a mule and hinny based on lineage. Abaye observed that a mule with a deep voice, like a donkey which brays, was the progeny of a mating between a female donkey and a male horse. Whereas, a mule with a shrill voice, like a horse which neighs, was the offspring of a female horse and a male donkey. Rav Pappa added that a mule with large ears and a small tail was the offspring of a mating between a female donkey and a male horse, while a mule with small ears and a large tail was the offspring of a female horse and a male donkey. Such differences generated the *halachic* question of a mule with a deep

voice, large ears, and small tail and a mule with a shrill voice, small ears, and large tail are considered the same species or are different species. This has relevance of whether these two varieties of mule with differing lineages, can share a common yoke to pull a wagon (*i.e.*, is this *kilayim*?).

Although a Jew cannot purposefully breed a horse with a donkey to yield a mule/hinny, once created can be used and, in fact, were highly valued and most useful animals. They were stronger than a horse of similar size and they inherited the endurance and disposition of a donkey, tending to require less food than a horse of similar size. Mules/hinnies also tend to be more independent than most domesticated equines. The mule/hinny exhibits hybrid vigor, *i.e.*, the improved or increased function of a biological quality in a hybrid offspring [30].

### Fish skin as sandpaper

The Talmud noted that wooden utensils were smoothed with the skin of a “tunny fish” (Chullin 25a). This statement, in conjunction with the Mishna in Kelim (16:1) which mentioned “rubbing with fish skin” as the usual method of finishing wooden utensils, are probably the first documented sources for the use of fish skin as sandpaper. Whereas the Mishna in Kelim did not identify the species of fish, the Talmud in Chullin identified the fish as “tunny,” a breed of smaller tuna (“little tunny;” *Euthynnus alletteratus*) found in the Mediterranean. Little tunny is a kosher fish with scales limited to along the lateral line and on the corselet, *i.e.*, a thick band of scales circling the body [31]. To be useful as sandpaper, the fish skin must be abrasive. From the description of the fish, it would appear that, in terms of abrasiveness, the skin of the little tunny was, at most, the equivalent of “fine” sandpaper.

In contrast, in terms of abrasiveness, the skin of shark would be the equivalent of “coarse” sandpaper. Documentation of shark skin for use as sandpaper can be traced to the British Empire in the mid 18th century, as it was used by cabinet makers to finish very fine work surfaces. Shark skin lacks kosher-type scales, but rather the skin is made of a matrix of tiny, hard, tooth-like structures, called dermal denticles or placoid scales. These structures are shaped like curved, grooved teeth and make the skin a very tough armor with a texture like abrasive “coarse” sandpaper [32].

## Leviathan

The third chapter of Chullin (67b) ends with a discussion of Leviathan, described as a kosher fish, with fins and scales. Rashi elucidated that Leviathan's fins shine brightly and illuminate the seabed beneath them. The point to be discussed is how Leviathan's fins illuminate the ocean floor.

Sunlight penetrates the oceans to a depth of about 656 feet, termed the photic zone; photosynthetic algae and phytoplankton dwell in this region. Only a small amount of sunlight penetrates further, with the region from 656 to 3,280 feet termed the dysphotic or twilight zone. In this later zone, the amount of light is insufficient for photosynthesis. Below 3,280 feet is the aphotic or midnight zone and this region of ocean is bathed in darkness [33]. As sailors and commercial fishing boats have never sighted Leviathan, it must be assumed that Leviathan dwells in the deepest most portion of the ocean, in regions that are void of light. If so, Leviathan's fins cannot reflect existing light; there must be another mechanism whereby Leviathan's fins illuminate the ocean floor of the aphotic zone. Bioluminescence may be the solution to the question.

Bioluminescent chemical reactions are processes in which chemical energy is changed to light energy (*i.e.*, essentially, it is the opposite of photosynthesis, in which light energy is changed to chemical energy). The glow of fireflies on a dark night is a bioluminescent reaction. Most deep-sea animals produce some bioluminescent light; either the animals take in bioluminescent bacteria to gain the ability to light up or the necessary chemicals for bioluminescence are inherent within the animal itself [34]. A good example of an aquatic bioluminescent creature is the lanternfish (*Symbiolophorus branadi*), a deepwater fish that gets its name from the ability to produce light. With over 200 different species, lanternfish are thought to be the most common deep-sea fish, growing to a length of six inches and comprising as much as 65% of the deep-sea biomass [35]. Apparently, Leviathan is a bioluminescent deep-sea fish, with the areas of luminescent concentrating in the fins. However, it is not known whether the bioluminescent mechanism is due to photophores, tiny light organs connected to Leviathan's nervous system, or to bioluminescent bacteria colonizing the fins.

## School days

In a debate over a certain *halachic* principle, R. Yochanan criticized Reish Lakish by saying to him,

“even school children know the answer” (Chullin 81b). Perhaps, this is the most powerful statement in Talmud Chullin, as it indicated that Jews had a school system. Rabbi K. Spero, an instructor at Aish HaTorah, compared the Jewish concept of education and literacy to that of the non-Jewish populations. “Throughout history, the powers-that-be realized that it is far easier to control an illiterate population than a literate one. Knowledge empowers the individual, and an empowered individual is a potential revolutionary.” The leaders purposefully kept the masses illiterate. This was the prevailing attitude of ancient Greece and Rome, with only 5% of the general population able to read and write. The schools were reserved for the children of the ruling minority, who owned land. In the Catholic Church of medieval Europe, the only literate people were monks and upper level clergy and all major libraries were in monasteries. The societal caste system in India and the feudal societies in China and Japan fostered illiteracy among the populace (36).

Education was of top priority to the Jews. During the reign of King Chizkiah, education was at its peak. As noted in Talmud Sanhedrin (94a), if one searched from Gevas to Anipras one would not find a boy or a girl, man or woman, who was not conversant with even the complex laws of *tumah* and *taharah*. In Bava Basra (21a) note was made that R' Yehoshua ben Gamala, a *kohen gadol*, ruled that teachers of young children should be appointed in each district and each town and that children should enter school at the age of six or seven. The unusual high literacy among Jews was recognized by the Arabs, who referred to Jews and “the people of the book” (36).

## Concluding statement

The thoughts presented herein were intended to elucidate some scientific topics in Talmud Chullin, not to replace the learning of the Talmud itself. Some ideas may be 100% accurate to explain the true meaning of the Talmudic text and other ideas, however, may be considered only educated guesses.

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