Genetically Modified Organisms: Will This Be the Greatest Kashrus Challenge of Modern Times?

By: DOVID LICHTENSTEIN

On November 19, 2015, the United States Food and Drug Administration (FDA) announced that, for the first time, it has approved a GMO—genetically modified organism—for commercial production and consumption. The approval was granted to AquAdvantage salmon, a product developed by the Massachusetts-based Aqua Bounty company, which calls it "the world's most sustainable salmon," touting the modified salmon as a game-changer in the seafood industry. The decision was issued twenty years after Aqua Bounty first applied for FDA approval, and it came not without a great deal of controversy surrounding the safety of GMOs and the possible long-term environmental impact of genetic modification on an industrial scale.

The idea behind the so-called "super salmon"—derisively dubbed "frankenfish" by its opponents—is to accelerate the fish's growth through genetic modification. The modified salmon needs just about 18 months after hatching to reach market size, as opposed to the three years that salmon normally requires. And, it can grow in habitats that would otherwise be inhospitable to salmon; specifically, it can grow in warmer waters. Currently, salmon is bred in waters in the North Atlantic and North Pacific, and has to be shipped to U.S. markets. The genetically engineered fish can be bred in land-based pools, significantly reducing shipping costs and delays.

Aqua Bounty alters the salmon by introducing to the fertilized eggs a growth-regulating gene from the Chinook salmon, which is known as the "king" of salmon, as it is the largest salmon in the Pacific. The gene is "turned on" and kept running by a "promoter" gene taken from the ocean pout, a fish that resembles an eel. The genetically altered eggs are then sold to salmon "farmers" who grow the fish for commercial sale.

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Having received FDA approval, AquAdvantage salmon may very well transform the meat and fish industry much as the iPhone transformed the cellular communication industry. With the precedent of an FDA-approved GMO in place, the floodgates have been opened for other companies to genetically modify chickens, turkeys and livestock, and to revolutionize the food market. Genetic modification could be used to accelerate growth, eliminate disease and enhance reproduction capabilities, all of which will serve to increase availability and thereby lower prices. AquAdvantage salmon is poised to be a game-changer not only in the salmon industry, but in the entire food industry.

This specter presents us with what might very well turn out to be the greatest *kashrus* challenge of the 21st century. In the not-too-distant future, we might see companies altering cows with genes taken from pigs or other non-kosher animals to accelerate growth or enhance taste. What would be the halachic status of the meat produced from such a cow?

In the case of AquAdvantage salmon, as with other genetically modified products, this question is actually irrelevant. Although the ocean pout—one of the two fish from which genes are taken for modifying the salmon—is not kosher, the gene from the ocean pout is not actually injected into the salmon egg. Aqua Bounty uses a system called PCR (polymerase chain reaction) whereby synthetic copies of DNA strands are reproduced. As such, no actual substance from an ocean pout is implanted in the eggs of AquAdvantage salmon, and there is thus no reason to question the fish's halachic status. And as long as this method remains the standard genetic modification technique, we can rest assured that our kosher poultry and livestock are, indeed, kosher.

Nevertheless, the prospect of GMOs transforming the food industry compels us to consider the situation of modification through implantation of genes from one species to another. How would the introduction of a gene from a non-kosher organism in a kosher organism affect its halachic status? If the resulting fish, for example, has all the physical properties of a kosher fish, would it nevertheless be forbidden if it contains a gene originating from a non-kosher fish?[1]

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[1] This question earned a great deal of attention in the early 2000s, when rumors circulated in Bnei Brak that genetically altered poultry had infiltrated the kosher market. Rabbi J. David Bleich wrote an extensive essay on the topic in *Tradition* (37:2, 2003, pp. 72–80), surveying the rulings of several leading sages who addressed the issue.

This question hinges on two different issues. First, we must ask whether a non-kosher genetic source affects the status of a fish that contains the two identifying characteristics of a kosher fish—fins and scales. In the case of AquAdvantage, the modified salmon bears full physical resemblance to ordinary salmon. Perhaps, then, even if it had actual non-kosher biological origins, perhaps they have no effect upon its halachic status, as it features the physical properties of a kosher fish. Secondly, even if we must, indeed, take into account the non-kosher status of the fish's "parents" despite its kosher properties, the lone gene taken from a non-kosher fish might be subject to the rule of *bittul* ("negation"), whereby a substance may be ignored due to its constituting an insignificant minority portion of a mixture.

I. Are Fins and Scales Enough?

Eggs and היוצא מן הטהור

The Gemara in *Maseches Niddah* (50b) establishes that a species of bird called תרנגול דאגמא is forbidden for consumption, whereas a different species called תרנגולתא דאגמא is permissible. The words תרנגול and תרנגולתא refer, respectively, to a rooster and a hen. It thus seems, at first glance, that the Gemara speaks here of a single species of bird, and establishes that the males are not kosher but the females are. This is, indeed, the approach of *Tosafos* to explaining the Gemara. *Tosafos* (ד"ה תרנגולתא דאגמא) write that the males of this species do not have the physical properties required by the Torah for a bird to be permissible for consumption, but the females do, and thus only the females may be eaten.

This reading, however, gives rise to the question of why we do not apply to this species the rule of היוצא מן הטהור טהור—that something produced by a kosher animal is kosher. The Mishnah in *Maseches Bechoros* (5b) establishes that if a kosher animal produces offspring with a genetic mutation, such that the offspring does not have the properties of a kosher animal, it is nevertheless permissible for consumption. Since it was born to a kosher animal, it is considered kosher regardless of its physical properties. Conversely, if a non-kosher animal gives birth to an animal that resembles a kosher animal, the offspring is forbidden for consumption despite featuring the physical characteristics of a kosher species. Since it was born to a non-kosher animal, it is not kosher. Seemingly, if we apply this rule to the תרנגול דאגמא, it should be permissible for consumption despite lacking the properties required for kosher birds. Since it was produced by a תרנגולתא דאגמא, which is a kosher bird, it should be kosher.

Tosafos answer this question by establishing that the rule of היוצא מן הטהור טהור applies to mammalian creatures, but not to fowl. The bird that emerges from an egg after hatching is not considered the halachic offspring of its mother, because its fetal development occurred outside its mother's body. *Tosafos* write:

> האם לא ילדה האפרוח, אלא ביצים הטילה, והאפרוח מעפרא קא גדיל, ונאסר ממילא ע"י סימני טומאה.
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> The mother did not give birth to the chick; rather, it laid eggs, and the chick grew from the earth, and is therefore forbidden by virtue of its non-kosher characteristics.

Since the chick develops outside the mother's body, and does not emerge from the mother's body in its complete form, it does not fall under the category of היוצא מן הטהור. We see it as the product of the "earth," as its development takes place on the ground, and therefore, its kosher status is determined by its own physical properties, and not by its mother's species. In the case of a תרנגול דאגמא, then, the bird is forbidden for consumption because it does not have the required characteristics of a kosher bird, despite its having been produced by a kosher bird.

A different view, however, is taken by *Tosafos* in *Maseches Chulin* (62b, ד"ה תרנגולתא דאגמא). There, *Tosafos* accept the argument that a bird with non-kosher physical characteristics is kosher if it was produced by a kosher bird. *Tosafos* are therefore compelled to advance an entirely different reading of the Gemara's ruling concerning תרנגול דאגמא and תרנגולתא דאגמא, and they claim that the Gemara refers to two distinct species with very similar names.

The Rambam appears to have followed the view taken by *Tosafos* in *Chulin*. In *Hilchos Maachalos Asuros* (3:11), the Rambam addresses the case of a chick which emerged from an egg laid by a *tereifah*—a bird that has a fatal wound and thus may not be eaten. Based on the Gemara in *Maseches Temurah* (31a), the Rambam rules that the chick is permissible for consumption. The chick is not viewed as יוצא מן האסור—something which was produced by a forbidden creature—because, as the Gemara explains, it developed outside the mother's body. When it left the mother bird's body, it was not yet a chick; it took form after the egg was laid, and thus the chick is not viewed as the product of the mother bird. However, the Rambam adds that the chick is permissible שאין מינו טמא—because it belongs to a kosher species of bird. Meaning, if the mother bird that laid the egg belonged to a non-kosher species, then the chick would be forbidden for consumption even if it had the properties of a kosher bird. According to the Rambam, a bird is not seen as its mother's offspring with respect

to the prohibition of *tereifah*, but is considered its mother's offspring with regard to its species. Although the bird develops outside the mother's body, nevertheless, its identity in terms of classification is determined by the mother's species, despite the fact it is not given the mother's other halachic characteristics, such as *tereifah*.[2] This view clearly reflects the position taken by *Tosafos* in *Maseches Chulin*, that a bird's status of *kashrus* is dependent upon the mother's species, regardless of the bird's physical properties.[3]

Rav Moshe Sternbuch, in a responsum published in *Teshuvos Ve'hanhagos* (vol. 4, *Y.D.* 184), cites and follows the view of *Tosafos* in *Niddah* that a bird's kosher status depends on its own characteristics, rather than its parents' species. He thus ruled that a chicken with all the properties of a kosher chicken is, strictly speaking, permissible for consumption even if it underwent genetic modification with genes from a non-kosher animal.[4]

This issue would, conceivably, directly affect the case of salmon genetically modified through the introduction of a gene from a non-kosher fish. Fish reproduce by laying eggs, and thus a fish, like a bird, is formed in an egg outside its mother's body.[5] Hence, according to *Tosafos* in *Niddah*, we may discount the gene taken from a non-kosher source, since a fish's identity is not determined based on its biological parents, as it does

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2 This distinction drawn by the Rambam between classification of species and the *tereifah* prohibition is developed at length by Rav Chaim Soloveitchik of Brisk, in *Chiddushei Rabbeinu Chaim HaLevi* (there in *Hilchos Maachalos Asuros*).

3 This issue also comes to the fore in a responsum of the Chasam Sofer (*Y.D.* 74) regarding a chicken fathered by a non-kosher bird, giving rise to the question of whether the father's non-kosher status affects the status of the egg and chick. The Beis Shlomo (*Y.D.* 144) writes that this would depend on the debate between these two views of *Tosafos*, as to whether a bird's status is determined based upon its own properties or the species of its parents.

4 Rav Sternbuch does, however, express concern that a non-kosher genetic source may yield an adverse spiritual effect on an animal's meat, which could, in turn, cause spiritual harm to those who eat it, and he thus concludes that such food should be avoided.

5 The Gemara in *Maseches Avodah Zarah* (40a) actually distinguishes in this regard between kosher fish and non-kosher fish, establishing that a kosher fish lays the egg before the fetus is developed, whereas the fetus of a non-kosher fish develops inside the mother's body and is then laid before hatching. Accordingly, a fish with fins and scales that was produced by non-kosher fish is forbidden for consumption, according to all views. (This point was made by Rav Shlomo Zalman Auerbach, in *Minchas Shlomo* 2:97:27.) In the case of genetically modified salmon, however, the eggs develop just like ordinary salmon's eggs, outside the mother's body, and thus according to *Tosafos* in *Niddah*, its kosher status depends on its own characteristics, and not those of its parents.

not grow inside its mother.[6] However, according to *Tosafos* in *Chulin*, and the Rambam, we cannot necessarily disregard the fish's non-kosher source. Since a fish's species with respect to *kashrus* depends upon the mother's species, the fact that the fish is partially produced by an ocean pout could, at least in theory, render it forbidden.

סימן or סבה

This question might hinge on a broader issue that a number of *Acharonim*[7] have addressed, regarding the nature of the סימני טהרה—the characteristics that determine a species' halachic status. Are species with these characteristics kosher because they feature these characteristics, or do these characteristics reveal that these species are permissible? In other words, should these characteristics be perceived as a סבה—the reason why these species are deemed permissible for consumption—or as a סימן—an indicator that these species are halachically suitable for consumption?

According to the first approach, the determining factor is, presumably, the creature's actual properties, irrespective of its origins. As such, a fish with fins and scales would be permissible even if it has undergone genetic modification through the introduction of a gene from a non-kosher fish. According to the second possibility, however, the fish's status depends on its formal classification, on whether or not it belongs to a kosher species (as the fins and scales are merely indicators of a kosher species). Hence, the presence of fins and scales on a genetically modified salmon would not necessarily mean that the fish is permissible.

As far as fish are considered, proof to the first possibility may perhaps be drawn from the Gemara's discussion in *Maseches Niddah* (51) concerning the properties of a kosher fish. The Gemara asserts that all fish with scales also have fins, and this gives rise to the question of why the Torah bothered to identify both characteristics. Seemingly, it would have sufficed to inform us that any fish with scales is permissible for consumption. For what purpose, then, did the Torah mention fins? The Gemara answers that the Torah made mention of the requirement of fins להגדיל תורה ולהאדירה—for the sake of glorifying Torah by adding more Torah material for us to study. The question remains, however, what value is there in

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6 This point is made by the Chasam Sofer, in his commentary to *Chulin* (66a).

7 *Tzofnas Panei'ach* (*Hilchos Maachalos Asuros*), Maharit 1:51. See also Rav Elchanan Wasserman's *Kovetz Shiurim* (vol. 2, *Kovetz Shemuos—Chulin* 62b, #27), where he suggests that the aforementioned debate between *Tosafos* in *Niddah* and *Tosafos* in *Chulin* hinges on this fundamental question.

adding unnecessary information? How is the Torah "glorified" by the addition of a superfluous word? The likely explanation[8] is that the Torah sought to instruct that it is these two features—the fins and the scales—that make a fish permissible. If these features were merely physical signs that reflected the fish's kosher status, then there would be no purpose served by adding the requirement of fins. The Torah chose to mention fins because the presence of both fins and scales is the reason why such a fish is permissible for consumption. Indeed, the Ritva, commenting on the Gemara's discussion, writes, ואולי הוא ג"כ גורם טהרתו, ואע"פ שהוא לבדו אינו גורם טהרה—"Perhaps it [fins] also causes its [the fish's] kosher status, even though it independently does not cause its kosher status." These comments clearly suggest that the Ritva viewed fins and scales as the סבה—the cause of the fish's kosher status—and not an indicator of its kosher status.[9]

In truth, however, this discussion may not necessarily be relevant to the question of genetically modified salmon, for two reasons. First, already the Maharit[10] noted that this conceptual question concerning the nature of the סימני טהרה seems to be answered by the aforementioned rule of היוצא מן הטהור טהור. The very fact that a creature's status is determined by its mother's species, and not by its own physical properties, would seem to prove that the סימני טהרה do not create an animal's kosher status, but rather reflect the kosher status of its species. As such, we return to the aforementioned debate among the *Rishonim* as to whether the rule of היוצא מן הטהור טהור applies to creatures that reproduce by laying eggs. The discussion regarding the nature of the סימני טהרה is of no practical relevance, as this issue has been halachically resolved with regard to mammals, and remains subject to debate in the context of fowl and fish, as we saw earlier.

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8 See Rav Yeshayah Horowitz ("*Shelah*"), *Amuda HaTorah*.

9 This point was made by Rav Shmuel Baruch Deutsch, in *Birkas Kohen*. It is also cited by Rav Shlomo Zalman Auerbach (in the responsum referenced above, note 5) in the name of the *Mitzpeh Shmuel*. Rav Shlomo Zalman dismisses the relevance of this argument, however, writing, אין להסיק הלכה מזה, ובפרט שזה נעשה על ידי בני אדם ולא לסימנים כאלה נתכונה התורה – "We cannot establish *halachah* on this basis, especially since this was done by human beings, and these are not the characteristics the Torah had in mind." In other words, even if we view fins and scales as the cause of a fish's kosher status, this is true only of fins and scales that appear naturally, and not through human manipulation, such as genetic engineering.

10 Referenced above, note 7. See also Rav Menachem Zemba's *Zera Avraham* (13:14).

Moreover, even if we view the סימני טהרה as indicators of kosher species, rather than the reason for an animal's permissible status, we might still permit genetically modified salmon that feature fins and scales. The very fact that the scientists did not modify the fish to such an extent that it no longer has fins and scales demonstrates that the modified fish still belongs to a kosher species. The presence of fins and scales, even if it does not create the fish's kosher status, nevertheless indicates that this fish still belongs to the group of kosher fish, despite the introduction of a gene from a non-kosher species. To illustrate this point, let us consider the example of a genetically modified kosher fish that no longer grows scales as a result of the modification. Undoubtedly, the absence of scales would render the fish forbidden, not because fins and scales are what make a fish kosher, but because the absence of scales testifies to the fact that the species has been altered, and the new species is not a kosher species. By the same token, if a process of genetic modification did not eliminate the fins or scales, we may determine that the fish still belongs to a kosher species.

II. *Bittul*

Our entire discussion thus far has revolved around the question of whether or not we must take into account the non-kosher origins of genetically modified salmon, or whether we may deem the fish permissible due to its own physical properties, without looking at its genetic history. We will now turn our attention to the second question, namely, whether we may apply the rule of *bittul* and thus disregard the non-kosher gene. That is to say, even if we must, indeed, take into account the fish's biological origins, and the presence of fins and scales does not suffice to render the fish permissible, may we nevertheless allow its consumption in light of the fact that the gene from the non-kosher species constitutes a minuscule percentage of the fish?[11]

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[11] It should be noted that if we permit genetically modified organisms solely on the basis of *bittul*, then although the product is permissible for consumption, it would be forbidden for a Jew to perform the modification procedure for the purpose of preparing meat. The well-established rule of אין מבטלין איסור לכתחילה forbids adding a non-kosher substance into kosher foodstuff with the intention that it would be nullified and thus have no halachic effect on the food. Hence, if a kosher animal containing a non-kosher gene is deemed permissible solely on the basis of *bittul*, as the non-kosher gene is negated by the majority, then it would be forbidden for a Jew to knowingly create such a situation. This point is made by Rav Yaakov Yisrael Fisher, in *Even Yisrael* (8:55), as discussed by Rav Bleich, in the article referenced above.

This question is vitally important with respect to the status of genetically modified mammals. As mentioned, the offspring of a non-kosher mammal is forbidden even if it has all the physical properties of a kosher animal. As such, if a gene is taken from a non-kosher mammal and implanted in the fertilized egg inside a kosher mammal, we might be compelled to forbid the offspring—unless we can apply the concept of *bittul* and thus ignore the offspring's non-kosher genetic origins.

מעורב בתחילתו

One argument against utilizing the concept of *bittul* in this context is a significant restriction on the rule of *bittul* imposed by the Mordechai (*Chulin*, 737). The Mordechai asserts that *bittul* does not apply in situations of מעורב בתחילתו—where the small portion of forbidden material was present from the inception of the item in question. If a food item contained a small forbidden component already at the time it came into existence, that component may not be ignored, even if it comprises a very small percentage of the food item. The law of *bittul*, according to the Mordechai, applies only when two substances existed independently and were then mixed together. If one of the substances constitutes a small proportion (generally, one-sixtieth) of the mixture, then it is deemed "negated" and thus has no halachic impact upon the other food. If, however, a product from the outset consisted of two substances, then they are both deemed halachically significant, regardless of their respective proportions. Thus, for example, the Mordechai rules that if a woman performing *chalitzah*[12] spits blood instead of saliva, the *chalitzah* is valid as long as even a minuscule amount of saliva is mixed with the blood. In such a case, we do not view the small portion of saliva as "negated" by the blood, since both fluids were produced in the woman's mouth from the outset, and thus they are not subject to the provision of *bittul*.

A number of *Acharonim*[13] drew proof to this position from the Gemara's discussion in *Maseches Chulin* (69a) concerning the law of בן פקועה—a living fetus removed from its mother's carcass after the mother was slaughtered. *Halachah* permits eating the fetus' meat without first slaughtering it, as it was covered by the slaughtering of the mother animal. However, if the mother had begun delivery before it was slaughtered, and part of the fetus—for example, its head—had exited the mother's body before

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12 If a man dies without children, his widow must marry his brother, unless she performs the *chalitzah* ritual, during which she spits in front of the brother.

13 Rav Moshe Katzenelenbogen, *Ohel Moshe* (22); and Rav Shimon Shkop, *Shaarei Yosher* (3:26).

slaughtering, that part of the fetus is forbidden for consumption. The Gemara raises the question of whether one may eat an animal born from a union of two בני פקועה, one of which had a part of its body outside the womb before its mother was slaughtered. Does the forbidden portion of one of the two parents render the offspring forbidden? The Gemara concludes that the animal would be permissible, but not because we apply the concept of *bittul*. Throughout its discussion of this case, the Gemara never proposes that the forbidden portion of one of the two parents should be negated by the majority and thus may be ignored. The reason, some *Acharonim* suggest, is because this animal came into existence as a "mixture" consisting of a small forbidden portion and a majority of permissible matter. As the animal was מעורב בתחילתו—meaning, it consisted from the very outset of both permissible and forbidden portions—we cannot apply the rule of *bittul*.

Returning to the case of a genetically modified organism, since the animal came into existence with a gene from a non-kosher source, it is, seemingly, not eligible for *bittul*, and it should thus be forbidden.[14]

In truth, however, it seems likely that the Mordechai's qualification would not apply to this case. The Noda BiYehudah (*Mahadura Tanina*, *Y.D.* 54), citing his son, asserts that the Mordechai established the exception of מעורב בתחילתו only with regard to certain forms of *bittul*. A fundamental distinction exists between the application of *bittul* in the context of מאכלות אסורות—the status of food products vis-à-vis consumption—and in other contexts. In other areas of *halachah*, the question that arises when two substances mix with one another is how to halachically define the mixture, given that it consists of two distinct components. The guiding principle in such situations, based upon the verse in *Sefer Shemos* (23:2), אחרי רבים להטות, is that the mixture's identity is determined based upon the majority component. According to the Noda BiYehudah, it is in regard to these situations that the Mordechai makes an exception in a case of מעורב בתחילתו. Since the substance was made from the outset with both

[14] It should be noted, however, that even if we accept this line of reasoning, the prohibition might apply only on the level of דרבנן—Rabbinic enactment. The Minchas Kohen (*Sefer HaTaarovos*, 1:4) asserts that although the Torah prohibits eating even very small amounts of forbidden food, this does not apply to forbidden food mixed with permissible food. Even when *bittul* does not occur, and the mixture is forbidden, eating small quantities of the forbidden food would be prohibited only מדרבנן. (See *Pri Megadim—Shaar HaTaarovos*, 2:2, who disputes this contention.) According to the Minchas Kohen, then, even if we cannot discount the gene taken from a non-kosher source, nevertheless, what's at stake is only a Rabbinic prohibition, giving us additional flexibility and grounds for relying on leniencies.

components, they are both halachically significant and the minority component cannot be disregarded. Thus, for example, in the case of *chalitzah*, where *halachah* requires the woman to expectorate saliva, the obligation is fulfilled as long as the substance that leaves her mouth includes even a small percentage of saliva.

When it comes to the consumption of food, however, *bittul* operates much differently. The principle of טעם כעיקר establishes that a mixture containing forbidden food may not be eaten if it contains the taste of the forbidden food. The determining factor in such situations is not the formal identity of the mixture, but rather the presence or absence of the forbidden food's taste. Accordingly, the Noda BiYehudah contends, it makes no difference whether the product consisted from the outset of both components, or if two separately preexisting entities mixed. Since the critical factor is the forbidden food's taste, the mixture cannot be prohibited if the forbidden food's taste cannot be discerned. As a practical matter, *halachah* generally presumes that a food's taste cannot be discerned when it constitutes a proportion of 1:60 or less. And thus, according to the Noda BiYehudah, even if a product consisted from the outset of a forbidden component, the product is permissible if the forbidden substance constitutes one-sixtieth or less of the entire product.

Quite obviously, a single gene constitutes far less than one-sixtieth of an organism, and the fish or animal should thus, seemingly, be permissible for consumption.

We might also add that our case might not even fall under the category of מעורב מתחילתו, since the gene from the non-kosher source is introduced to the egg and immediately "negated" by the majority at that point. Although the salmon, for example, emerges from the egg with this gene, that gene had already, halachically speaking, been "negated" the moment it was added to the egg. As such, the fish is entirely permissible.

עיקרו כך

One may, however, contend that *bittul* cannot be applied in this case in light of a ruling of the Rashba, in one of his responsa (3:214). The Rashba addresses the case where a small amount of vinegar originating from non-Jewish wine was mixed with honey to produce medicine. This mixture is forbidden for consumption, the Rashba rules, despite the fact that the vinegar constitutes a small proportion of the mixture, because עיקרו כך—this is the ordinary way of making this product. Since the vinegar is supposed to be added to the honey, it cannot be considered "negated" by the honey, and the mixture is therefore forbidden.

We might argue, then, that once it becomes standard procedure to add a gene to modify a certain creature, this gene cannot be discounted, despite its constituting a minuscule proportion of the final product.

However, the Noda BiYehudah (*Mahadura Tanina*, *Y.D.* 56) noted that many *Rishonim* do not accept the Rashba's position, and one may rely upon their lenient ruling. The Noda BiYehudah added that even according to the Rashba, the mixture would be forbidden only מדרבנן—on the level of Rabbinic enactment, as opposed to Torah law—and thus there is certainly room to rely on the lenient position.[15]

דבר המעמיד

Another argument which one might advance to deny the possibility of *bittul* in this case is the rule regarding דבר המעמיד—a stabilizing agent in a food product. If the stabilizer is forbidden for consumption, then the food containing the stabilizer is forbidden regardless of how small a proportion of the food the stabilizer comprises. The reason underlying this rule is that the stabilizer's presence is unmistakably discernible, as it lends the food its texture. As its effects are clear and evident, it cannot be ignored, even if it constitutes a minuscule portion of the product.

At first glance, this principle should be applied to a foreign gene added for the purpose of accelerating growth. Although the forbidden gene comprises an infinitesimally small proportion of the organism, nevertheless, its effects are discernible in the creature's rapid growth. One might argue, then, that we cannot disregard the forbidden gene in light of its evident impact on the creature.

There is, however, an important exception to the rule of דבר המעמיד that undermines this argument. The *Shulchan Aruch* (*Y.D.* 87:11) permits eating a food product with a non-kosher stabilizer (that comprises less than one-sixtieth of the product) if the product also contains another stabilizer which is permissible for consumption. The special stringency of דבר המעמיד applies only if the non-kosher stabilizer is the product's sole stabilizing agent. Accordingly, a non-kosher gene added to an organism should not render the organism forbidden, as it is not the only substance that causes the creature to grow. The gene combines with other material in the organism—which is, of course, entirely permissible—to advance its growth, and thus it is subject to the law of *bittul*.

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15 For more on the Noda BiYehudah's discussion, see Rav Yitzchak Weiss, *Minchas Yitzchak* (2:28:10).

This argument, however, would not be valid if the genetic modification discernibly enhances the flavor of the meat. If, for example, manufacturers begin introducing a pig gene into livestock to enhance the beef's flavor, it would be difficult to apply the rule of *bittul* to permit the beef. Since the minute portion of forbidden substance is clearly discernible, it cannot be overlooked, and thus the product would, perhaps, be forbidden.

Orlah and the Grafted Branch

In truth, we might perhaps have a compelling halachic precedent for applying *bittul* to such a situation, and viewing the implanted gene as assuming the identity of the host organism.

The Gemara in *Maseches Sotah* (43b) addresses the case of a branch taken from a tree within the first three years after its planting—whose fruit is forbidden due to the prohibition of *orlah*—and grafted onto an older tree. The Gemara rules that all the fruit produced by the tree, including by the grafted branch, is permissible for consumption, because the grafted branch loses its identity and assumes the identity of the host tree. Even though the grafted branch likely affects certain biological properties of the host tree, nevertheless, since it has become part of the host tree, it loses its identity and is regarded as a branch of an older tree, which is not subject to the prohibition of *orlah*.

Rav Sternbuch, in the aforementioned responsum, suggests drawing an analogy between this case and the situation of a genetically modified organism. In the latter case, too, a small portion of one species is implanted within another. Thus, just as the *orlah* branch loses its original identity and the fruit it subsequently produces is not regarded as *orlah*, similarly, a gene introduced in the egg of a different species should lose its identity and assume the identity of the host species. This analogy might thus prove that the concept of *bittul* is applicable in the case of a genetically modified organism, despite the effects of the implanted gene on the host organism.

חצי שיעור

In truth, even if we would conclude that the non-kosher cannot be negated through the concept of *bittul*, we would still have good reason to permit the consumption of the genetically modified creature, due to a theory postulated by the Noda BiYehudah elsewhere in his writings concerning the prohibition of חצי שיעור—eating small quantities of forbidden food.

Although *Beis Din* would not administer corporal punishment to violators guilty of eating small quantities of forbidden food (generally, less than a *k'zayis*), nevertheless, *Halachah* forbids eating any amount. However, the *Tzelach* (Talmud commentary written by the author of *Noda BiYehudah*), in *Maseches Pesachim* (44a ד"ה ועוד נלע"ד), makes an exception to this rule. He notes that the reason given for the law of חצי שיעור is חזי לאיצטרופי—the fact that the consumption of a small quantity of forbidden food could mark just the beginning of one's consumption, and combine with food eaten subsequently to reach the amount which renders one liable to *malkos* (lashes). In other words, the consumption of small quantities is forbidden only because a small quantity could eventually combine with additional food to comprise the minimum amount that warrants *malkos*. Accordingly, the *Tzelach* contends, in a case where there is no possibility of reaching the minimum quantity prohibited by the Torah, חצי שיעור is permitted. The case he discusses is one who wishes to eat a small morsel of *chametz* in the final moments of Pesach. Since *chametz* will become permissible by the time one would be able to eat a *k'zayis* of *chametz*, there should, in theory, be no reason to forbid the consumption of a small bit of *chametz* at this point. For this reason, the Tzelach contends, the Rambam (*Hilchos Chametz U'matzah* 1:7) cites a Biblical source[16] for the prohibition of eating small amounts of *chametz*. If this were forbidden solely because of חצי שיעור, then it would be permissible to eat a small portion of *chametz* in the final moments of Pesach. The Rambam therefore resorted to a Biblical source, to establish that eating small amounts of *chametz* is intrinsically forbidden, and not merely due to the possibility of one subsequently reaching the amount of a *k'zayis*.

This theory of the *Tzelach* should, conceivably, apply also to situations of a food product containing a minuscule portion of forbidden food which is not, for whatever reason, subject to *bittul*. *Beis Din* can punish a sinner for eating forbidden food only if the violator partakes of a כזית בכדי אכילת פרס—a *k'zayis* of forbidden food within the time-frame of אכילת פרס, which is commonly identified as anywhere from four to nine minutes. According to the *Tzelach*, it would seem, in a case where there is no theoretical possibility of consuming a *k'zayis* of forbidden food within this time frame, such as if the forbidden substance constitutes a fractional portion of the food one eats, the food should be permissible.

This is certainly the case with regard to a kosher animal containing a single non-kosher gene. The amount of non-kosher substance in this animal's meat constitutes an infinitesimally small proportion of the meat. As

16 לא יאכל חמץ (*Shemos* 13:3).

such, even if *bittul* cannot take effect, the meat should be permissible because one could not possibly partake of a *k'zayis* of forbidden foodstuff within the period of אכילת פרס.

Conclusion

When it comes to fowl, it would seem that genetically modified fowl that has the physical properties of a kosher bird is certainly kosher, since according to all opinions, the status of birds is determined based on a bird's physical characteristics, and not on its biological origins. As far as fish is concerned, according to one view among the *Rishonim*, a fish with fins and scales is forbidden for consumption if it was produced by non-kosher fish. Mammals, according to all opinions, are forbidden if they were produced by non-kosher animals, regardless of their own physical characteristics.

Nevertheless, it seems likely that we may apply the rule of *bittul* and thus overlook the forbidden element within a genetically modified kosher fish or animal. And even if *bittul* does not apply in such a case, the forbidden gene constitutes such a small portion of the organism that there is no possibility of consuming a *k'zayis* of the creature's forbidden substance within the period of אכילת פרס, and thus the fish or animal is permissible (according to the position of the *Tzelach*). ☙