

Section 22

Forbidden Mixtures

The Torah restricts three kinds of forbidden mixtures (“*kilayim*”): (1) hybrid animal species; (2) hybrid plant species, and (3) clothes made from both wool and linen (“*kilayim shatnez*”). For each class of *kilayim* we herein determine (i) what defines that class (ii) the scope of the restriction on that class¹ and (iii) the purpose for the restrictions on that class. I also discuss whether the laws of *kilayim* might apply to Genetic Engineering in §22.4. Obviously, this section does not appear in *Adderet Eliyahu*.

The reader should note that the present section of *Adderet Eliyahu* is the second of three sections written by Rav Bshyatzki’s student, Rav Calev Afendopolo after Rav Bshyatzki’s passing.

The topics covered in this section are:

1. Introduction
2. *Kilayim* of Animals
3. *Kilayim* of Plants
4. Genetic Engineering
5. *Kilayim Shatnez*

“You already know that the prohibition on kilayim with respect to animals is because that which is born of such a union will not be successful in being fruitful and multiplying and this is against His will, may He be exalted, for thusly He said: ‘be fruitful and multiply and fill [the world]’ ” -Adderet Eliyahu’s Inyan Kilayim Part 1 Ch 4 Daf 192A Col 2

§22.1 Relevant Passages and the Verse “You shall not plow an ox and a donkey together”

The laws of forbidden mixtures (*kilayim*) are mentioned in two separate passages:

1. *“You shall keep my statutes. You shall not breed your livestock as kilayim; You shall not sow your field with kilayim, and garments of kilayim shatnez shall not come upon you”* (Leviticus 19:9); and
2. *“You shall not sow your vineyard with kilayim lest the entirety be made hekdes², the seed which you show and the produce of the vineyard. You shall not plow with an ox and a donkey together. You shall not wear shatnez, wool and linen, together”* (Deuteronomy 22:9-11).

The prohibition on *kilayim* of plants and *kilayim shatnez* are given in Leviticus and repeated again in Deuteronomy. The prohibition on *kilayim* of animals, however, is mentioned only in Leviticus. Thus some Sages suggested that the statement in Deuteronomy “you shall not plow with an ox and a donkey together” refers to the *kilayim* of animals otherwise missing from Deuteronomy. They argued that the verb “plow” refers to the act of mating. This is mistaken, however. The clause “you shall not plow with

¹ For example, we will determine that while one is forbidden to breed hybrid animal species, one is permitted to derive benefit from hybrids.

² See §13.1 regarding the laws of *hekdes*.

an ox and a donkey together” constitutes a separate prohibition that refers to literal “plowing”. The prohibition on literal “plowing” immediately follows the prohibition on *kilayim* of plants because it is also about fieldwork, not because it is also about *kilayim*.

Plowing with an ox and a donkey together is prohibited to prevent the stronger animal from causing great pain to the other. Similarly, any two animals of different strengths may not plow together, even should they be of the same species.

§22.2 Kilayim of Animals

§22.2a Defining Kilayim of Animals

The Torah prohibits breeding two separate animal species together: “you shall not breed your livestock as *kilayim*” (Leviticus 19:9). For example, one may not breed a horse and a donkey to produce a mule. The word *kilayim* comes from the root *keleh* (“trapped”) because a *kilayim* species is a “hereditary dead end”; it cannot produce another being like it. For example, male mules are sterile. Likewise, a grafted plant will not produce more plants like it, it can only produce plants that look like one of the source plants. For example, a tree produced by grafting apple branches to an orange tree can produce either apple or orange trees but not another hybrid tree. In addition to the fact that a *kilayim* of animals cannot produce others like it, a *kilayim* of animals is distinguished by the fact that it does not resemble either of its parents.

Although the Torah only explicitly forbids breeding *kilayim* of livestock, the prohibition applies to any two species of animals. The case of livestock is singled out only because people more commonly breed livestock than wild animals. Furthermore, *Adderet Eliyahu* holds that attempting to breed two species together is forbidden even if they could never produce offspring that is *kilayim*. For example *Adderet Eliyahu* mentions that it is forbidden to try breeding a cow and a pig or a cow and a camel despite the fact that these species clearly cannot produce offspring in the way that a horse and a donkey can produce a mule.

One may breed two animals of the same species of *kilayim* together. For example, one may attempt to breed two mules. However, in order for two animals to be considered of the same “species of *kilayim*”, their parents must match both in terms of species and of gender. For example, one may not breed a mule (the offspring of a male donkey and a female horse) with a hinny (the offspring of a female donkey and a male horse). One may not breed an animal considered *kilayim* with either of its parent species. For example, one may not breed a mule with a horse or with a donkey.

Notes on §22.2a

Defining the Term Species Infertility

One of the criteria *Adderet Eliyahu* uses to identify a *kilayim* of species is the inability for a member of that species to breed others “like it”. The inability to breed others “like it” is different from the complete inability to breed. I refer to the inability to breed others “like it” as “species infertility” from this point forward. Indeed,

Adderet Eliyahu provides a grafted plant as an example of the inability to breed others “like it”. The grafted plant can produce offspring, but it is considered *kilayim* because its offspring resembles one of the original plants (not the grafted hybrid).

Fertile hybrids also exist in the animal kingdom. A female mule can, in rare cases, produce offspring with either a horse or a donkey. Nevertheless, a female mule is considered *kilayim* because it cannot produce others like it. That is, it cannot produce offspring with another mule, it can only reproduce with a horse or a donkey.

Adderet Eliyahu notes that one may breed two members of the same *kilayim* species together. Presumably, this is because in the cases where this is possible, the offspring resembles both parents and can produce others like it. Two hybrids produce offspring very rarely in the animal kingdom; but it is possible. The modern scientific term “hybrid speciation” refers to such cases where hybrid offspring of a given species can reproduce with each other but cannot produce with either of their parent species. Hybrid speciation is more common in plants than in animals.

§22.2b Scope of the Prohibition on Kilayim of Animals

While one is forbidden from creating a *kilayim* of animals, one may use purchase or otherwise benefit from *kilayim* of animals produced naturally or by a Gentile. Unlike the prohibition on *kilayim shatnez*, which forbids using *shatnez* as clothing, the prohibition on *kilayim* of animals forbids breeding such animals but says nothing about using them: “You shall not **breed** your livestock as *kilayim*”. Although in some cases we are restricted in deriving benefit from an act forbidden to Jews even if a Gentile performs the act, this rule does not apply in the case of *kilayim* of animals. This is evidenced by the fact that King Solomon rode a mule (1 Kings 1:33).

Should a Jew create a *kilayim* of animals, however, it is immediately confiscated as *hekdesh* for the *kohanim*. This is known through *hekeish*: just as *kilayim* of plants grown by Israelites are confiscated as *hekdesh* (§22.3b), so too *kilayim* of animals bred by Israelites are confiscated as *hekdesh*. Some Sages held that the owner could then redeem this *hekdesh* for one-and-one-fifth of its value, in accordance with the general rules of *hekdesh* (§13.1). However, others held that in this case the Torah was referring to a non-redeemable subset of the standard *hekdesh* – the *cherem* (§13.1).

§22.2c Reason for the Prohibition on Kilayim of Animals

There are several reasons for prohibition on producing *kilayim* of animals. First, *kilayim* generally do not successfully reproduce to create others like them. This is against God’s will as it is written “be fruitful and multiply” (e.g., Genesis 1:22).

Second, interbreeding species is in opposition to the natural order of things. More specifically, Rav Calev states that it both changes the nature of reproduction and opposes the acts of creations performed in Genesis. Rav Calev, thus, asserts that interbreeding changes and opposes the “laws of heaven”.

Third, because interbreeding of species does not frequently occur naturally, it generally requires human involvement. As already established in (§18.9), *Adderet Eliyahu* holds that humans should not be

involved in sex for any reason other than proper continuation of the species. Although generally not considered erotic, the interbreeding of animals causes one to dwell on sex and is thus forbidden.

Notes on §22.2c:

Adderet Eliyahu offers three reasons for the prohibition on *kilayim*: In my opinion, however, the only valid explanation for the prohibition on *kilayim* is the prohibition on creating species-infertility. *Adderet Eliyahu's* second and third explanations appear to me to be mistaken. I evaluate each of *Adderet Eliyahu's* explanations below.

The Creation of Species-Infertility

Interbreeding tends to produce species-infertility (defined in §22.2a). According to *Adderet Eliyahu*, this stands against God's will. Rav Calev offers direct textual evidence that this is so: "Be fruitful and multiply" (Genesis 1:22). Furthermore, the restriction on *kilayim* is not the only command aimed at curbing species infertility. The Torah prohibits neutering animals³ as well as marriage with an infertile man (Deuteronomy 23:1, §18.4e). Such a marriage would cause an otherwise fertile woman to be unable to reproduce. One might also argue that the Torah prohibits acts of homosexuality in order to further curb infertility. Regardless, there is ample textual evidence that the Torah strives to curb infertility, or more specifically species-infertility. It therefore, seems likely that the restrictions on *kilayim* of animals are meant to prevent species-infertility.

Natural Law

Adderet Eliyahu's second explanation for the prohibition on creating *kilayim* is that interbreeding violates the "law of heaven" and the natural order of things. The classification of acts as "natural" or "unnatural", however, is arbitrary. At what point does an act become "unnatural"? Perhaps human involvement makes an act unnatural? By this definition, though, anything a human does should be considered unnatural and therefore forbidden. Perhaps then an act's rarity in the natural world is the cause of it being unnatural? This alternative definition is equally problematic because there is no clear threshold for when an act is sufficiently infrequent to become "rare". Also, while animal interbreeding may be rare, plant *kilayim* are very frequently produced without human involvement. If the "rarity" of interbreeding in the natural world were the reason for the prohibition for *kilayim*, then the Torah would only include a prohibition on animal *kilayim*, not plant *kilayim*. More fundamentally, because humans are natural creations that are part of the natural world humans cannot violate natural laws. The only absolute natural laws are the immutable laws of physics. Then so long as interbreeding is physically possible, interbreeding is within God's "natural order" even if it is not within His moral order.

In fact, *Adderet Eliyahu* offers no textual evidence for its assumption that "natural law" should apply to "moral law". The Torah clearly promotes a conception of what is right and what is wrong, but it never discusses the "natural order" in the context of morality. To the contrary, the Torah holds that so long as we act morally, we may alter the natural world to our liking: "and God said: let us make man in our image, and he shall rule over the fish of the sea and the birds of the sky and over the cattle and over the entire earth and every crawling thing that crawls upon it" (Genesis 1:26). Far from being told not to alter God's "natural" laws, we are told to be like him - "let us make man in our image" - and, like God, manipulate the world through creative acts ("rule over...the entire earth"). Of course, our dominion is subject to God's will. Thus, we may act as rulers only so long as we remain subject to the *halakhic* constraints He has given us. Failure to do so may jeopardize our dominion over nature. For example, when the Israelites abused the land and rejected the *shemita* year, they were exiled from it (2 Chronicles 36:20-21).

³ See *Keter Torah* on Leviticus 22:24

Human Involvement in Interbreeding

Adderet Eliyahu states that humans should not be involved in sex for any reason other than proper continuation of the species. Thus, people are forbidden from interbreeding animals, because this might cause their mind to dwell on sex and then seek out unnecessary intercourse. I have already questioned the validity of *Adderet Eliyahu's* statement that all unnecessary sex, even with one's spouse, is discouraged ("Notes on §18.9"). Furthermore, I doubt that the Torah would go to such lengths as to prevent people from thinking of sex. In fact, the *Tanakh* itself frequently discusses sex.

Breeding Species-Fertile Hybrids

Having established that causing species infertility is the fundamental concern underlying the restrictions on *kilayim* of animals and of plants, we now discuss an issue raised by this position. In rare cases, a hybrid animal species might be species-fertile. In other words, although the species is created by breeding two separate species, members of the new hybrid species may all reproduce with each other. This is known as "hybrid-speciation".

Should hybrid speciation be permitted? *Adderet Eliyahu* answers this question in the negative: although one may breed two members of a *kilayim* species together, to begin with one may not produce the *kilayim* species by breeding two disparate species together (§22.2a). However, in contrast to *Adderet Eliyahu* I believe there is reason to permit "hybrid speciation". Although the hybrids produced through interbreeding do not resemble their parents, they would still be the progenitors of a species that is itself fertile. Thus, such animals are exceptions to the *kilayim* prohibition, which (I believe) exists only to curb species-infertility.

Furthermore, there is a compelling practical reason to permit such speciation. In addition to breeding *kilayim* of plants, one is prohibited from planting such *kilayim*: that is, one is prohibited from planting *kilayim* created by breeding two separate species of plants together. Many common plants, including most forms of wheat, are species-fertile hybrids. Forbidding such plants would result in an unbearable agricultural burden especially because hybrid-speciation in plants is ubiquitous throughout the natural world. Even durum wheat and emmer wheat, two of the five grains that are known to leaven and can therefore be used to create *matzah* (§5.3b, §5.5), are themselves hybrids. Because we have long planted what we need to make *matzah*, this suggests that species-fertile hybrids are not considered *kilayim*. That being said, *Adderet Eliyahu* permits producing plant hybrids from two species that display slight differences but otherwise greatly resemble each other. I suspect the aforementioned wheats and many common hybrid plants would fall under this category. As a legal norm, however, *Adderet Eliyahu's* ruling regarding "different but similar looking" species is far more ambiguous and harder to justify than one permitting any hybrid speciation.

On the other hand, there are also good reasons to forbid hybrid speciation. While I have argued that hybrid-speciation should be carved out as an exception to the literal prohibition, because hybrid speciation does not produce species-infertility, one might object that this argument does not fully consider the possibility that the textual prohibition is intentionally overly broad. The Torah may have forbidden hybrid-speciation because it can lead one to start breeding hybrids that are species-infertile. This is particularly likely to happen to plant breeders. Whereas species-fertile hybrids are extremely rare in the animal kingdom, they are quite common among plant species. At the same time, species infertile plant hybrids are also quite common. Thus, a plant breeder who begins to mix permitted plants may soon get confused and start mixing forbidden plants.

Ultimately, however, I believe this explanation to be flawed. As we have noted, *Adderet Eliyahu* permits the breeding of hybrids from two similar looking, but ultimately different plant species. This vague definition of what constitutes a "species" for the purposes of *kilayim* is more likely to cause plant breeders to err with respect to *kilayim* than by permitting hybrid-speciation. Furthermore, one who rejects *Adderet Eliyahu's* exception for

“similar looking species” but nevertheless upholds the prohibition on hybrid speciation, runs into the problem of impracticality. As previously mentioned, under such a hypothetical hardline position many important plant species (including some species of wheat traditionally used to make *matzah*) would then be forbidden.

§22.3 Kilayim of Plants

§22.3a Defining Kilayim of Animals

The Torah mentions the prohibition on *kilayim* of plants twice:

1. “you shall not sow your field with *kilayim*” (Leviticus 19:9)
2. “You shall not sow your vineyard with *kilayim* lest the entirety be made *hekdes*, the seed which you show and the produce of the vineyard” (Deuteronomy 22:9-11)

The prohibition applies both to the interbreeding of plant species and the creation of hybrid plants through grafting. The Rabbanite Sages argued that this prohibition applies to growing different kinds of plants in the same field. The Karaite Sages, however, argued that the prohibition only applies to the creation of hybrids through grafting or interbreeding partially because they viewed it as parallel the prohibition on creating hybrid animals.

§22.3b Scope of the Prohibition on the Kilayim of Plants

One is permitted to benefit from hybrid plants bred, planted, or grafted by Gentiles. Unlike the prohibition on wearing *kilayim shatnez*, the prohibition on *kilayim* of plants mentions only the act of planting, not benefitting from the plants. Furthermore, we learn from *hekeish* that just as benefitting from *kilayim* of animals is permitted, so too is benefitting from *kilayim* of plants. One may not, however, request or command a Gentile produce a *kilayim* of plant.

Should one produce a *kilayim* of plant, it immediately becomes *hekdes*: “You shall not sow your vineyard with *kilayim* lest the entirety be made *hekdes*, the seed which you show and the produce of the vineyard” (Deuteronomy 22:9). Some Sages held that the original owner could then redeem this *hekdes* for one-and-one-fifth times its value, subject to the general rules of *hekdes* (§13.1). Others held that in this case the Torah was referring to a non-redeemable subset of *hekdes* – a *cherem* (§22.3b).

If one grows *kilayim* in a field, then only the *kilayim* becomes *hekdes*. If, however, one grows *kilayim* in a vineyard of grapes all plants in that vineyard become *hekdes*: “you shall not sow your vineyard with *kilayim*, lest the entirety be made *hekdes* the seed which you sow and the produce of the vineyard” (Deuteronomy 22:9).

Notes on §22.3b:

I do not understand why the Sages distinguish between vineyards and fields in some regards, but not in others. Although any *kilayim* of plants become *hekdes* whether grown in a field or in a vineyard, pure-bred plants only become *hekdes* if they are grown together with a *kilayim* species in a vineyard but not a field. This distinction is

particularly perplexing, because we learn that plants in a field become *hekdesh* by applying *hekeish* to the verse discussing *kilayim* grown in a vineyard (Deuteronomy 22:9). Why then should this *hekeish* not similarly classify as *hekdeish* pure-bred plants in a field containing *kilayim*?

§22.3c Reason for the Prohibition on the Kilayim of Plants

In addition to the creation of infertility, producing hybrid plants is forbidden because it was once a common idolatrous practice⁴. *Adderet Eliyahu* describes this idolatrous practice in detail, but I do not elaborate here.

Notes on §22.3c:

In its primary discussion of the reason for the prohibition on hybrid plants, *Adderet Eliyahu* states only that grafted plants are important to idolatry. In addition to its connection to idolatry, I believe that Rav Calev also holds concerns of species infertility to be a major reason for the restrictions on *kilayim* of plants. He uses hybrid plants as an example when explaining how the meaning of the word *kilayim* is related to infertility⁵. Furthermore, he uses the criteria of species-infertility to decide if certain plants are *kilayim*⁶. He probably omits species-infertility in his primary discussion of the reason for restricting *kilayim* of plants only because he had already discussed it in the case of animal hybrids.

§22.4 Genetic Engineering:

§22.4a Introduction

Some Israeli Karaites with whom I have spoken hold that genetic engineering is an instance of *kilayim*. They argue that genetic engineering mixes the genes of different species in the same way as traditional interbreeding. This argument is *hekeish* because the prohibition on *kilayim* does not literally mention “mixing” species; it mentions *breeding kilayim* animals and *sowing kilayim* plants. In particular, the *hekeish* used in this position is a *hekeish* of equal-rulings (§1.5). Those adopting this theory apparently believe that the reason for prohibiting interbreeding applies equally to the case of genetic engineering. Perhaps they see both interbreeding and genetic engineering as unnatural mixing of genetic material.

In my opinion, however, the contention that genetic engineering is forbidden does not follow from the reason for the *kilayim* prohibition. I have previously argued that species-infertility is the only discernible reason for the restrictions on *kilayim* of plants and of animals (“Notes on §22.2c”). Considerations such as the “naturalness” of the act, are ill-defined and irrelevant (“Notes on §22.2c”). Therefore, it is presumptuous to prohibit genetic engineering on the grounds that such an act is “unnatural mixing”. Rather, (according to my view) the question that must be asked is: “does genetic engineering cause species-infertility?”. I ultimately conclude that genetic engineering is generally permitted, except in cases where it is known in advanced to cause species infertility.

There are many different kinds of genetic-engineering. In my analysis of this issue, I divide genetic engineering into two subsets, each of which raises a unique set of *halakhic* questions:

⁴ The practice is described in Maimonides’ Guide to The Perplexed 3.37. There are many English translation of this Rabbanite work. Maimonides states that his knowledge of the practice comes from the work “Nabbatean Agriculture”, an Arab-Muslim work on the occult practices of Babylonians, Chaldeans, and other idolaters.

⁵ *Adderet Eliyahu* Inyan Kilaym Part I Ch 1 Daf 191B Col 2.

⁶ See the discussion of the “magdanuzi” plant, in *Adderet Eliyahu* Inyan Kilaym Part II Ch 2 Daf 195a Col 1.

1. genetic engineering that affects the reproductive cells of an organism, thereby producing traits transmittable to offspring; and
2. genetic engineering that affects a limited number of cells within the organism, thereby inducing manipulations not transmittable to offspring.

Each of these two categories assumes that a gene from one species of organism is being inserted into at least some of the cells of an organism of a different species. There may be other kinds of genetic engineering including the mixing of genes from organisms of the same species, the removal of genes, and the artificial induction of mutations. However, these methods in no way pose a question of *kilayim*. Thus, I only discuss the case of inserting genes of one species into another species.

Now, for most people, only genetically modified foods raise questions of practical relevance. I will therefore say a few words about such foods before returning to the general discussion. First, it should be noted that if genetically modified plants are planted by gentiles, then they are permissible regardless of whether they constitute *kilayim* because *kilayim* plants are forbidden only if planted by or at the command of a Jew (§22.3b). Arguably, in many countries, gentiles can safely be assumed to be behind the planting process. Likewise, if a genetically modified animal is bred by a non-Jew it is permissible for a Jew to eat or benefit from it (§22.2b). Thus, even if one holds genetic engineering to be *kilayim*, one does not necessarily need to avoid genetically modified foods because a Jew is not necessarily involved in the forbidden steps of its preparation. Alternatively, one might conclude that the risk of a Jew possibly being involved is too high to bear and should therefore be avoided. For now, I only wish to call the reader's attention to this issues, but I do not herein discuss when a halakhic risk is high enough to be considered unbearable. This is largely because I do not believe such foods to be a type of *kilayim* in the first place. Genetically modified foods are generally an example of genetically engineered traits transmittable to offspring. I discuss such genetic engineering in §22.4b and conclude that they raise no halakhic problems.

Returning to the general issue, it may serve the reader to consider a common and straightforward example of between-species gene insertion. The Green Fluorescent Protein gene (GFP) is a gene endemic to some forms of jelly fish. When expressed in a cell, GFP causes that cell to glow green under ultraviolet light. Researchers will frequently insert the jelly fish GFP gene into a wide variety animals, plants, or microorganisms to better visualize biological structures. GFP's effect can be quite pronounced; mice with GFP in their genome will visibly glow green under ultraviolet light. Because GFP is originally found in jelly fish and the GFP mouse is visibly different from the rest of its species, the creation of the GFP mouse is thus an example of mixing between species and creating offspring that does not resemble either parents. I ultimately argue, however, that creating a GFP mouse is permissible because it is not an instance of species infertility.

§22.4b Genetic Engineering of the Entire Genome or of Reproductive Cells

It is possible to alter the genome of an organism by insertion of a gene. That is, every cell in said organism will contain a copy of the inserted gene. When this is done, the reproductive cells of that organism (e.g., sperm or egg cells) also contain the inserted gene. Thus, all children of that organism have the potential to inherit the inserted gene. For example, descendants of a GFP mouse have the potential to inherit the trait of glowing green under UV light. Because the offspring of the genetically engineered organism resembles its parents, genetic engineering an organism's genome does not produce species-infertility. Such genetic engineering should therefore not present an issue of *kilayim*.

Although breeding two GFP mice is not an instance of *kilayim*, one might argue that producing a GFP mouse from two regular mice does constitute *kilayim*. Indeed, while *Adderet Eliyahu* permits breeding two organisms of the same hybrid species, it forbids the production of hybrids that do not resemble either parent even should those hybrids themselves be species-fertile (*i.e.*, it forbids hybrid speciation). The creation of a GFP mouse from

two regular mice is similar to the case of hybrid speciation. While the GFP mouse can produce offspring with other GFP mice that also glow green, the first GFP mouse will not resemble its parents. Nevertheless, I believe the production of such a mouse should be permitted. I have argued that even if hybrid speciation is truly forbidden (I believe it is not), it is only forbidden because it may eventually lead one to mix species that produce infertile hybrids (“Notes on §22.2c”). However, unlike in the case of animal or plant breeding, only a small subset of genetic engineering produces species infertile hybrids; thus the same rationale cannot justify a general prohibition on genetic engineering.

§22.4c Localized Genetic Engineering of a subset of the organism’s cells

It is also possible to insert foreign genes into only a subset of an organism’s cells. For example, in order to visualize the neurons in a specific part of the mouse brain, a localized injection of the GFP gene can be performed⁷. Because the reproductive cells of the mouse are not affected, the mouse’s offspring will not have any glowing cells.

Because such gene insertion happens after conception (and frequently after birth), localized genetic engineering does not resemble the case of interbreeding. It resembles more the case of grafting one species of plant onto another species. If grafting is prohibited only because of its relation to idolatry (“Notes on §22.3c”), then clearly the same rationale cannot justify a prohibition on localized gene insertion. I believe however, that grafting is prohibited because it produces species-infertility (“Notes on §22.3c”). A lemon tree grafted onto an olive tree can seed either lemon or olive trees, but not another hybrid tree resembling the grafted tree. Similarly, a mouse with the GFP gene in only some of its cells cannot produce another GFP mouse⁸. Is the case of injecting the jelly fish GFP gene into a living mouse, an act of “grafting” the jellyfish onto the mouse? In order to answer this question I address two separate kinds of localized gene insertion.

In some cases of localized gene insertion, the gene remains restricted to the cells in which it was originally introduced. For example, GFP inserted into the genome of neuron cells will only be present in the original neurons because neurons do not divide to form new cells. In such a case, I argue that the insertion of GFP does not resemble the grafting of plants specifically because the presence of the GFP does not “grow” in the animal. It is far more similar to making a permitted alteration to an animal, such as tattooing cattle (in a humane fashion), than to grafting plants. Like the GFP insertion, the Tattoo does not spread. And again like the GFP insertion, the tattoo will not be present in the cattle’s offspring. Therefore, although a localized GFP insertion of this nature gives an animal a trait that is not passed on to offspring, it is just as permissible as other alterations to animals such as tattooing cattle.

Another case of gene insertion raises a more difficult *halakhic* question. In some cases of gene insertion, the cells originally altered to contain the inserted gene will replicate such that the number of cells expressing that gene grows⁹. Indeed, the genetic modification lives and “grows” in a way that resembles the growing branches of a grafted plant. Despite its resemblance to grafting, I believe this kind of modification to be permitted. This is because it bears even stronger resemblance to a permissible case – namely, that of breeding animals who have viral infections.

⁸ Unless of course the subset of cells in question include some sperm or egg cells

⁹ There can also be other reasons for which the gene insertion will spread. For example, a virus capable of replication might be used to insert the gene.

Many viruses neither kill their host nor are fully eradicated by their host's immune system. After infection, they reside permanently in their host. This can cause the host to express certain traits as a result of the viral DNA. Furthermore, in the case of some viruses the offspring of infected individuals cannot inherit such a virus from their mother while in the womb. Thus, like hybrid species, the children of these parents do not express their parent's traits if those traits are caused by the virus. Finally, the original virus produces more viral particles and periodically infects more cells. The viral infection, being capable of spreading within the organism, resembles the growing branches of a grafted plant. It likewise resembles the "spread" of a gene insertion. This resemblance is not surprising because localized genetic engineering is usually accomplished through specially tailored viruses. Just as it is permitted to breed an infected organism with an uninfected organism of the same species without concern of *kilayim*, it is permissible to breed a genetically engineered organism with an unmodified organism.

Let us consider a real virus as an example. The human HSV-1 (commonly referred to as "oral herpes") virus hides in its host. A large portion of the population experiences periodic outbreaks of oral cold sores as a result of the HSV-1 virus. Even when an outbreak subsides, the virus continues to reside in the host. The virus thus causes the "trait" of recurring oral cold sores. Furthermore, because an oral infection of HSV-1 resides only in the mouth, not the reproductive cells, the oral cold sores "trait" will not be passed on to children. This "trait" then raises the same *halakhic* questions as a modification produced through localized genetic engineering. Granted, the laws of *kilayim* do not apply to humans, but similar examples exist in animals (there are animal HSV viruses, for instance). I mention HSV-1 only because I am more familiar with human pathology. In any case, nothing in the Torah suggests that we should consider the presence or absence of a viral infection when determining whether something is *kilayim*. This is despite the fact that viral infections inducing visible traits were no doubt present at the time of the Torah and their symptoms, even if not their causes, could have been described in terms understandable to Israelites. Likewise, I do not believe the Torah intends to include localized genetic engineering in the prohibition of *kilayim*. Such engineering greatly resembles viral infections largely because it is often implemented by using viruses.

One might argue that such a minor change as oral cold sores does not constitute a change of "species". By contrast, localized genetic engineering - like the case of tree grafting- induces more major changes. This assumption is mistaken, however. Generally, localized genetic engineering only induces minor changes. Often, these traits are not even visible. For example, even if enough GFP were inserted to an outwardly visible part of the body, it would still not be visible under normal lighting (UV light is required). By contrast, cold sores are fairly obvious and visible under normal light. Finally, it would be difficult to determine when something ceases to be a "minor" change and becomes a "major" change.

§22.5 Kilayim Shatnez

§22.5a Defining Kilayim Shatnez

The Torah prohibits a type of clothing known as *kilayim shatnez*: "garments of *kilayim shatnez* shall not come upon you" (Leviticus 19:9). The meaning of the word "*shatnez*" is explained in a later verse: "You shall not wear *shatnez*, wool and linen together" (Deuteronomy 22:11).

Although the Torah makes clear that "*shatnez*" is a mixture wool and linen, the Sages disagreed as to what exactly constitutes "wool" and "linen". Some said that each material serves as an example of a larger class of materials; wool represents animal materials, and linen represents plant materials. Other Sages said that "wool" refers only to sheep's "wool" and linen only to actual linen. Finally, some said that "wool" can refer to any kind of wool (e.g., sheep or goat wool) but that linen only refers to actual

linen. *Adderet Eliyahu* concludes that this latter opinion is correct. Although “wool” may refer to wool from any kind of animal, it does not refer to animal hairs. Thus, products mixing linen and animal hair are not considered *kilayim shatnez*.

As mentioned above, any article of clothing that is made of both wool and linen is *kilayim shatnez*. This includes garments made of interwoven wool and linen as well as garments that are made of wool cloth tied together with linen threads. Furthermore, it includes woolen *tzitzit* tied to a linen garment- an act permitted as an exception by the Rabbanite Sages. However, wearing a wool garment on top of a separate linen garment or vice versa does not raise an issue of *kilayim shatnez*. One may even use a wool garter to close a linen garment, because the garter is not a permanent fixture on the clothing. The case of the garter is like that of wearing a wool garment on top of a linen garment.

§22.5b Scope of the Prohibition on the Kilayim Shatnez

The Torah prohibits wearing garments of *kilayim shatnez*, stating “you shall not wear shatnez” (Deuteronomy 22:11) and commanding that such garments “shall not come upon you” (Leviticus 19:9). However, one may purchase, produce, sell, or otherwise benefit from *shatnez* garments or clothes. For example, one may use a *shatnez* bed sheet. However, one may not wear said bed sheet as a garment. It is permissible to dress the deceased in burial shrouds of *shatnez*, because the *mitzvot* apply only to the living.

§22.5c Reason for the Prohibition on the Kilayim Shatnez

There are two reasons for the prohibition on *kilayim shatnez*. First, such garments once had idolatrous connotations. Second, according to Rav Yefet and Rav Aharon the Elder, such garments are prone to deterioration by *tzara'at*. Only wool or linen garments are prone to developing *tzara'at*: “when the plague of *tzara'at* is in the garment, whether a wool garment or a linen garment” (Leviticus 13:47). To protect garments from *tzara'at*, the Torah prohibits mixing these two susceptible materials into one garment.