

SA YD 87:3.2024

Suzanne Brody

Lab-Grown “Milk”¹

Approved on November 14, 2024, by a vote of 16-1-0. Voting in favor: Rabbis Aaron Alexander, Jaymee Alpert, Emily Barton, Suzanne Brody, Nate Crane, Elliot Dorff, David J. Fine, Joshua Heller, Barry Leff, Daniel Nevins, Matthew S. Nover, Micah Peltz, Avram Reisner, Karen Reiss Medwed, Robert Scheinberg, and Miriam T. Spitzer. Voting Against: Rabbi Joel Pitkowsky. Abstaining: None.

שאלה (Question)

There is a new technology to create the proteins found in milk using material from vegetable and fungal sources. The proteins synthesized in this way are either physically similar or identical to proteins that can be found in cow milk, even though nothing from a cow is used in the creation of these proteins. Would the proteins (and products made using them) be kosher? If kosher, are they dairy or pareve?

תשובה (Teshuvah)

The Technology

A growing number of startups from Silicon Valley to Singapore are rapidly joining the race to create lab-grown “milk.” Unlike plant-based “milks” such as soy milk, almond milk, and others, this new lab-grown milk contains the same proteins as milk obtained from an animal. This “milk” is created using a precision fermentation process to artificially reproduce the proteins in curds (casein) and whey.² The company that developed the first whey protein with the same DNA sequence as that found in cow’s milk already sells its products across 5,000 stores in the US,³ another company has recently been greenlit for use in Canada,⁴ as has one in Israel.⁵

¹The Committee on Jewish Law and Standards of the Rabbinical Assembly provides guidance in matters of halakhah for the Conservative movement. Individual rabbis, however, are authorized to interpret and apply halakhah for their communities.

² A brief overview (simplified) of the process can be viewed in the video here: [Using precision fermentation to outperform cows/ Remilk Science](#)

³ “Lab-grown dairy is the future of milk, researchers say,” <https://www.theguardian.com/food/2021/jul/31/lab-grown-dairy-is-the-future-of-milk-researchers-say>

⁴ [Remilk receives first of kind regulatory green light in canada](#)

⁵ [There's a quiet, dairy revolution brewing in the labs of the Middle East | WIRED Middle East](#)

One of the foremost companies in the business, California-based Perfect Day⁶, explains that it uses fungi to make dairy protein that is “molecularly identical” to the protein in cow’s milk, says co-founder Ryan Pandya. Perfect Day has assembled the gene that codes for whey protein in cow’s milk, and introduced it into a fungus. When the fungus is grown in fermentation tanks, it produces whey protein, which is then filtered and dried into a powder used in products including “cheese” and “ice cream”. In other words, for the first time in the history of milk, actual cow’s milk proteins (whey and casein) are being produced in something other than a cow. The process doesn’t involve any animals and doesn’t contain lactose⁷, so Pandya feels perfectly comfortable describing the product as “vegan-friendly.” Those at Remilk, an Israeli company using the same technology, are particularly enthusiastic about the fact that cultured milk produced in this manner is “sustainable, ... made without cows and free of lactose, cholesterol, antibiotics and growth hormones.”

US Governmental Agencies and Laws

Currently in the United States, the way to label these products and the wording to be used for the warning on the packaging are under dispute, much of which revolves around the legal definition of the word “milk”⁸ and does not yet clearly specify how companies should label products containing lab-grown (or, as some prefer, cultured) milk. This can pose a problem for

⁶ “Sustainable Animal-Free Dairy & Protein - Perfect Day”, <https://perfectday.com/>

⁷ According to the National Institute of Diabetes and Digestive and Kidney Diseases “Lactose is in all milk and milk products and may be found in other foods and drinks.” [Eating, Diet, & Nutrition for Lactose Intolerance - NIDDK \(nih.gov\)](#) In other words, the logic is as follows: Lactose is a sugar found only in milk and milk products. Therefore, anything that contains lactose is dairy. However, not everything that is dairy must contain lactose. There are numerous lactose-free dairy products available today. As explained by the Spruce eats, “Since lactose comes from milk, a product that is dairy-free will not have lactose in it. This means that a product that is dairy-free is also lactose-free; but remember that a product that is lactose-free is not necessarily dairy-free.” [The Differences Between Lactose-Free and Dairy-Free \(thespruceeats.com\)](#)

⁸ “Dairy farmers urge FDA to crack down on animal-free dairy milk labels”; <https://agfundernews.com/dairy-farmers-urge-fda-to-crack-down-on-animal-free-dairy-milk-labels>; the National Milk Producers Federation (NMPF), whose “mission is to foster an economic and political climate in which dairy producers and the cooperatives they own can thrive and prosper,” represents US dairy farmers, by providing a forum for dairy producers and the cooperatives they own to participate in public policy discussions. “NMPF advocates policies to Congress, U.S. and foreign government agencies, industry organizations, the news media, and the public,” and they maintain that federal standards of identity for ‘milk,’ limit the term to the “lacteal secretions.” <https://www.nmpf.org/wp-content/uploads/2023/06/NMPF-letter-to-FDA-Commissioner-re-Synthetic-Dairy-Product-Labeling-06262023.pdf> and <https://www.accessdata.fda.gov/scripts/cdrh/cfdocs/cfcfr/CFRSearch.cfm?fr=131.110>

consumers with a dairy allergy,⁹ as this allergy is typically to the *proteins* (which are in lab-grown milk) rather than the *lactose* (which is not found in cultured milk).¹⁰ This distinction between the proteins and the lactose is why many people who have an allergy to cow milk (as opposed to an intolerance to lactose) can consume goat milk products.¹¹ Furthermore, while reproduction of the milk proteins, whey and casein, appear to be the secret to creating complex molecules that deliver dairy's unique taste and texture, it should be noted that the precise composition of milk varies not only between species, but even in a single animal depending on the season and the animal's diet, making it exceedingly difficult to depict the chemical formulation of milk or even define milk by its components.

Since there are no clear governmental rules or guidelines regarding how to label these products, many companies, including Perfect Day encourage customers to check allergen labels closely and they do their best to ascertain that their partners (i.e., those using their product to create items such as cheese) include a milk allergen warning on the front and back of product labels, e.g. "Contains: Milk protein."¹² While this may satisfy many, it does not have the power of legislation behind it and as such, remains a suggestion rather than a requirement.

While the whey protein (β -Lactoglobulin) that food tech startups are making with microbes in fermentation tanks is bio-identical to the bovine version, dairy farmers and others dispute the idea that if you mix it with water, oil, sugar, gums, vitamins and minerals and put it in a carton, you can call the end product 'animal-free dairy *milk*'. NMPF president and CEO Jim

⁹ "Perfect Day is creating 'real' dairy, without cows | CNN Business", <https://www.cnn.com/2021/08/12/business/perfect-day-dairy-protein-hnk-intl-spc/index.html>, "Cow Milk Without the Cow Is Coming to Change Food Forever | WIRED", <https://www.wired.com/2015/04/diy-biotech-vegan-cheese/>

¹⁰ "Milk Allergy vs. Lactose Intolerance: Definitions, Symptoms, Diagnosis (healthline.com)", <https://www.healthline.com/nutrition/dairy-allergy-vs-lactose-intolerance#lactose-intolerance>

¹¹ In general, the gross composition of cow's milk in the U.S. is 87.7% water, 4.9% lactose (carbohydrate), 3.4% fat, 3.3% protein, and 0.7% minerals (referred to as ash). Milk composition varies depending on the species (cow, goat, sheep), breed (Holstein, Jersey), the animal's feed, and the stage of lactation. It is worth noting that in this study, the effect of **species was significant on the concentrations of protein, casein, lactose, and SCC. When compared with cow milk, goat milk had lower concentrations of protein (-3.1%), casein (-15.7%), and lactose (-8.7%) but higher contents of SCC (+386.7%).** [Sokratis Stergiadis, Natalja P. Nørskov, Stig Purup, Ian Givens, and Michael R. F. Lee, "Comparative Nutrient Profiling of Retail Goat and Cow Milk," *Nutrients*. 2019 Oct; 11(10): 2282. (Published online 2019 Sep 24.) and "The Comparison of Nutritional Value of Human Milk with Other Mammals' Milk - PMC (nih.gov)" <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC7284997/>]

¹² "Sustainable Animal-Free Dairy & Protein - Perfect Day", <https://perfectday.com/>

Mulhern maintains that it is “baseless, preposterous and absurd” to call these manufactured products ‘milk’. Instead, he believes that “[i]t would be much more accurate to label it as a ‘synthetic whey beverage.’ Milk is a natural, biologically produced, highly complex and nutritious food containing 400+ fatty acids, eight types of whey protein and four types of casein proteins, vitamins, minerals, and countless other bioactive compounds. Taking just one of these proteins (β -Lactoglobulin) and adding some sugar, sunflower oil and other ingredients does not make dairy milk”.

Ultimately, whatever decisions the dairy industry, United States governmental agencies, or similar bodies in countries around the world come to regarding requirements and best practices for labeling products with these lab-grown milk proteins do not answer questions regarding halakhic status. *Milchik* and dairy need not be synonymous, and we do not need to wait for any secular government’s language around these products to consider the matter of kashrut. We might be tempted to say that “lab-grown milk” is, in fact, dairy, so as to alert the consumer to the presence of milk proteins. Such reasoning, however, ignores the significant body of *halakhah* regarding what constitutes a mixture of meat and milk, as well as the more recent explorations of other types of food produced in laboratories.

Relevant Halakhic Precedents

Comparison with Lab Grown Meat

Since much of the *halakhah* relevant to dairy products is intertwined with that relevant to meat, it behooves us to take a look at how *halakhah* has dealt with the phenomenon of lab-grown, or cultured, meat. Like lab-grown milk, cultured or cultivated meat is produced in a laboratory and is the creation of food that is molecularly identical to meat. One crucial difference between lab-grown milk and lab-grown meat is that cultivated meat is meat produced *from cells harvested from an animal* while lab-grown milk is created *from the insertion of a gene that was created in a laboratory into a fungus*¹³. In addressing the kashrut status of lab-grown meat,¹⁴ *poskim* such as Rabbi Nevins believed that it was critical to note the source of the original cells

¹³ Currently, all of the lab-grown milk is being produced by gene insertion into a fungus. The same process can also be applied using bacteria or yeast for the fermentation process. While this may have implications for Passover, it does not alter the primary halakhic argument for non-Passover kashrut, in which case one may wish to rely upon the argumentation employed by Rabbi Paul Plotkin in *Supervision of Passover Food*, approved by CJLS, December 7, 2011.

¹⁴ Daniel Nevins, *The Kashrut of Cultured Meat*. Approved by CJLS, November 14, 2017.

from which the meat is grown as they are still present in the final product. Ultimately the Rabbinical Assembly's Committee on Jewish Laws and Standards ruled that in order for cultured meat to be kosher, the animal from which the cells are harvested must be a kosher animal.¹⁵

Having ascertained that it is possible for cultured meat to indeed be kosher, the next question addressed was whether cultured meat is “meat” or “pareve.” Unlike other foods produced in a lab, such as gelatin and rennet which pass through an inedible and even a toxic stage,¹⁶ the cells gathered from a live animal will, despite any manipulations done as part of the process, remain some sort of viable animal cell, which makes it more difficult to dismiss the “meatyness” of the resultant product. In 2017, Rabbi Nevins therefore ruled that cultured meat, which is intended to be identical in both substance and style to meat from an animal, should be treated as meat for purposes of kashrut. More recently, in 2023, Rabbi David Lau, Israel’s Ashkenazi chief rabbi, issued the ruling that at least *some* cultured meat may, indeed, be pareve in instances where companies use a process in which its “meat” is cultivated from stem cells taken from fertilized embryos rather than from cells of muscle tissue as stem cells retain the potential to become a variety of cell types while muscle cells have already differentiated to be part of the meat of the animal.¹⁷

Milk in Halakhah

In contrast to lab-grown meat, there is not even a single cell from animal milk used in the production of lab-grown milk, which prompts the question, how is milk defined and addressed in the halakhic literature? As mentioned above, our *halakhic* understanding of dairy comes largely from the prohibition against mixing milk and meat. Our Sages noted¹⁸ that the phrase “לֹא-תִבְשֵׁל לֶאֱמֹר בְּחֵלֶב אִמּוֹ” (“you shall not cook a kid in its mother’s milk”) appears three times in the Torah¹⁹ and from that, we have derived an understanding both of the phrase itself and gained valuable insight into what constitutes both “meat” and “milk.”

¹⁵ In other words, cultured pork would not be considered kosher, even though the meat didn’t grow inside a pig, because the original cells came from a non kosher animal.

¹⁶ Isaac Klein, "The Kashrut of Gelatin," *Responsa and Halakhic Studies* (KTAV Publishing House, 1975)

¹⁷ Lau, David, חוות דעת הלכתית בשר מתורבת המיוצר במפעלכם, January 17, 2023; [Kosher cheeseburgers? Chief rabbi rules some cultured meat may not be 'fleishig' | The Times of Israel](#); [חוות-דעת-הלכתית-מהרב-הראשי- בשר המיוצר במעבדה מתא לא בשרי](#); [חוות-דעת-הלכתית-מהרב-הראשי- בשר המיוצר במעבדה מתא לא בשרי.pdf \(timesofisrael.com\)](#); see also Stav, David

¹⁸ See B. Kiddushin 57b

¹⁹ Exodus 23:19, Exodus 24:26, and Deuteronomy 14:21.

Before discussing milk and its sources, our Sages examined the meaning of “אֵי” “a kid.” In the Babylonian Talmud (on *Hullin* 113b), we learn that the term “kid” does not refer specifically to a baby goat, but instead comes to include all types of animal meat. We derive this from the fact that there are several places in the Torah where it is written, “a goat kid.” Since it must be specified that this is a “goat kid” or a “sheep kid,” in a place where it is stated only, “kid,” all animal meat like it is implied.²⁰

However, we are not actually permitted to eat all kinds of meat. Therefore, it is perhaps unsurprising that the Rabbis used the three-fold repetition of the phrase to exclude three categories of animals from this prohibition against mixing milk and meat: wild beasts, fowl, and unclean beasts.²¹ It is important to note that not only is the flesh of these animals exempt from the prohibition of consumption with milk, it is also the case that none of the categories of animals specified by this restrictive reading (i.e., free-roaming beasts, birds, or mammals which are forbidden for consumption by Jews) produce milk that we use. Wild animals, even those that produce milk to feed their own offspring, will not allow themselves to be milked by a human and birds do not produce milk at all. We are forbidden to eat all parts of an unclean beast²², including any milk such an animal might produce. The one notable exception to this rule is human breast milk, which can be eaten, and is even considered pareve²³, but may not be mixed with meat out of concern for how such an action might appear to an observer.²⁴

Rambam explained what constitutes permitted milk consumption explicitly in the *Mishneh Torah, Forbidden Foods 9:3*:

(ג) אין אסור מן התורה אלא בשר בהמה טהורה בחלב בהמה טהורה שנגאמר (שמות כג יט) (שמות לד כו) (דברים יד כא) "לא תבשל גדי בחלב אמו" ... אכל בשר בהמה טהורה (שבשלו) בחלב בהמה טמאה. או בשר בהמה טמאה (שבשלו)

²⁰ Rashi on Exodus 23:19 provides examples.

²¹ Sifrei Devarim 104:8; *Hullin* 113a

²² This is true of flesh, edible skin, or things they produce, such as eggs or milk

²³ Since human beings are not considered in the laws of animal food, they do not have a status as either kosher or not. It therefore appears that the definition of *dairy* is milk from a kosher animal, which does not apply to a human being, and therefore leads to the determination that human breast milk is neither prohibited (as is the case with milk from non-kosher animals) nor dairy (as the milk from kosher animals) and is, instead, pareve.

²⁴ [Shulhan Arukh YD 87:4](#); הגה: אין צריך שיעור: הגה: אסור לבשל בחלב אשה מפני מראית העין ואם נפל לתוך התבשיל בטל ואין צריך שיעור: הגה: ונראה לפי זה דכל שכן דאסור לבשל לכתחלה בחלב טמאה או בשר טמא בחלב טהור (ד"ע) ודוקא בשר בהמה אבל בעוף דרבנן אין לחוש: It is forbidden to cook meat in a woman's milk, due to suspicion; if such milk mixes with food, it is considered dissolved, without the food needing to present a specific quantity.

בְּחֵלֶב בְּהֵמָה טְהוֹרָה מִתֵּר לְבִשֵׁל וּמִתֵּרַת בְּהֵנָה וְאִין סִיבִין עַל אֲכִילָתוֹ מִשּׁוּם בִּשּׁוֹר
בְּחֵלֶב:

(3) According to Scriptural Law, the prohibition involves only [a mixture of] meat from a kosher domesticated animal and milk from a kosher domesticated animal, as it says “do not boil a kid in its mother’s milk.” ...But it is not speaking about meat from a kosher animal and milk from a non-kosher animal [or vice versa] (i.e. The prohibition involves only a kid that could be eaten and milk of which one could partake...)

The phrase “milk from a kosher domesticated animal” makes it clear that Rambam and the rest of our illustrious Sages used the term “milk” to refer to that which comes from an animal, similar to what we find in the dictionary today.²⁵ In fact, the discussion in *Hullin* regarding milk remaining in an animal’s udder at the time of slaughter makes it clear that there are cases where something with the composition of milk made in an animal is, for the purposes of the prohibition against mixing milk and meat, deemed “not-milk.”²⁶

מתני' הכחל קורעו ומוציא את חלבו לא קרעו אינו עובר עליו ...

MISHNA: They tear the udder and remove its milk. If they didn't tear it, they have not committed a transgression.

(Mishnah *Hullin* 8:3, my translation)

תניא כלישנא קמא דרב כחל שבשלו בחלבו מותר קבה שבשלה בחלבה אסור

The Gemara comments: Similar to the language Rav first used, it is taught in a *baraita*: An udder that one cooked in its milk is permitted.

The stomach that's cooked with its milk is prohibited.

²⁵ “A whitish fluid, rich in fat and protein, secreted by the mammary glands of female mammals (including humans) for the nourishment of their young, and taken from cows, sheep, etc., as an article of the human diet.” Oxford English Dictionary entry for “milk”

https://www.oed.com/dictionary/milk_n1?tab=meaning_and_use#36851056

²⁶ At the very least according to the Rabbis’ understanding of what constitutes part of the d’oraita prohibition against mixing milk and meat.

ומה הפרש בין זה לזה זה כנוס במעייו וזה אין כנוס במעייו

And what is the difference between this and that (i.e. between milk found in a stomach and an udder)? This one collected in its innards. But that one never collected in its innards. (i.e. Milk collects in a calf's stomach, but milk in an udder is not considered milk because it is considered to still be part of the cow's body.)
(B. Hullin 109b)

Looking at these passages closely, one notes that while it still resides in the udder, the liquid is “not milk”²⁷ nor are any of its components.²⁸ Once the substance leaves the udder, it takes on the status of milk. The composition of the liquid does not change between the time that it is in the udder and the time it leaves the mother's body, but its identity (especially in relation to the laws of kashrut) does.²⁹

“Lab-grown milk” too fits the definition of “not milk,” having not been extracted from an udder, or indeed, from an animal at all. In fact, the entire process requires absolutely no animal involvement at all, not even to obtain the DNA sequence for the whey protein.

Despite the clear difference in how they are produced, lab-grown milk and milk expressed from an animal can be impossible for most people to distinguish from one another on visual inspection. There is therefore a concern of misleading impressions, *mar'it ayin*, should lab-grown milk be deemed pareve. Such a concern, however, is mitigated by the fact that even in Talmudic times, it was known that there were kosher foods which mimicked the taste of non-kosher items.³⁰ Today, consumers already regularly eat soy, wheat-gluten, or other vegetable based “meat” at dairy meals, and pareve “milk” from soy, almonds, cashews, coconuts and other plants at meat meals. While it is worth considering the general impact on the system of kashrut

²⁷ At least in relation to the prohibitions against cooking milk and meat together. Other instances of liquids with similar composition to milk or products that can be derived from milk are also considered to be exempt from the prohibition against milk and meat. These include: one who cooks [meat] in whey is exempt (B. Hul. 114a); in the milk of a male [animal] is exempt (B. Hul. 113b).

²⁸ יש מי שאומר דנסיובי דחלבא (פי' חלב המתמצת מקפאון הגבינה) אינם בכלל מי חלב ואסור מן התורה אלא מי חלב היינו אחר שעושים הגבינה מבשלים הנסיובי והאוכל צף מלמעלה ולא נשאר בו אלא מים בעלמא זהו הנקרא מי חלב. A certain author opines that casein is not comparable to whey and is forbidden by biblical law. Whey is the liquid that, after cheese preparation, separates from the curd floating on the surface; this milk, being very watery, is called whey. SA YD 87:8

²⁹ Similar shifts in the identity of a substance based on its location in or out of a body occur with eggs (those found *in* a slaughtered bird are considered "meat" like the bird, but when eggs are laid by a hen, they are pareve; SA YD 87:5).

³⁰ As explained by Yalta, B. Chullin 109b

that the increasing prevalence of such pareve alternatives to both *milchik* and *fleishik* products may have in the future, such a meta-discussion is not the purview of this paper. For current purposes, we have many precedents that make it understood that clear labeling can alleviate concerns regarding *mar'it ayin* as well as health concerns for those with a protein allergy.

פסקי דין (Rulings)

1. “Lab-grown milk” produced as described in this teshuvah is kosher. (The Kashrut status of products created using this ingredient will depend on its other ingredients.)
2. Having not come from an animal’s udder (or any other part of an animal), these products are “not milk” as it is defined by halakhah and therefore are to be considered pareve.³¹

³¹ Those particularly concerned with *mar'it ayin* may wish to have either the container or a mushroom visible to indicate the source of the lab-grown milk (much as some did with an almond when the use of almond milk as a milk substitute began).

A Brief Biology Lesson and Glossary

Terms:

1. **Gene**: Has the ability to completely or partially control the expression of one or more traits in a living organism.
2. **Protein**: Is a large molecule that consists of many amino acids joined together to form long chains, much as beads are arranged on a string. Proteins are of great nutritional value and are directly involved in the chemical processes essential for life.
3. **Lactose**: The primary sugar found in milk
4. **Whey**: A protein that results after milk has been curdled and strained.
5. **Casein**: The protein that is the primary emulsifier (it helps in mixing oils, fats, and water) in milk.
6. **Gene synthesis** refers to a group of methods that are used in synthetic biology to construct and assemble new genes from nucleotides, the components that make up the gene. Artificial gene synthesis does not require template DNA, allowing it to be completely synthesized in the laboratory.
7. **Protein synthesis**: The result of protein synthesis is a chain of amino acids that have been attached, link by link, in a specific order.

Precision fermentation is a process that uses genetically modified microorganisms to produce specific proteins, enzymes, and other compounds. Here's a breakdown of how it works:

1. **Gene Insertion**: Scientists insert genes that code for the desired product into the DNA of microorganisms like yeast, bacteria, fungi, or algae.
2. **Cultivation**: These modified microorganisms are then cultivated in bioreactors, where they are fed a nutrient-rich feedstock, usually sugars.
3. **Production**: As the microorganisms grow and multiply, they produce the target compound through their metabolic processes.
4. **Extraction**: The desired product is then extracted from the bioreactor and purified to ensure it meets the required standards.

lactose-free vs dairy-free milk

Lactose-free milk is simply milk that has the milk sugar (lactose) removed by either 1) adding an enzyme (lactase) that breaks down the lactose into its simple sugar components (glucose and galactose) or 2) using a filtration process (like ultra filtration) to completely remove the lactose from the fluid milk product. Lactose-free products are not the same as dairy free products. Lactose-free products may still contain dairy proteins. Lactose intolerance and a dairy allergy are different ways that a person's body may react differently to milk consumption. Lactose intolerance is a reaction to the milk sugar, while a dairy allergy is a reaction to the protein.