Houston Journal of Health Law & Policy

FUTURE FARE: CULTURED MEAT'S REGULATORY PATH TO TABLETOP REALITY

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I. INTRODUCTION

In an era where the limits of nature are being tested by human hands, the advent of lab-grown meat stands at the intersection of science, commerce, and ethics, heralding a novel way of addressing the

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growing global appetite for meat. In a world grappling with the increasing demands of its population, the quest for sustainable alternatives that can mitigate environmental pressures, advocate for animal welfare, and guarantee human health is becoming more pressing.[1] Lab-grown meat, developed in laboratories rather than derived from conventional animal farming, acts as a harbinger of change in a world teetering on the brink of ecological and environmental uncertainty.[2] As alluring as this innovation appears, it is not immune to the tempestuous complexities that accompany such momentous winds of change.

As with any transformative product, particularly one challenging the very fabric of our diets and industries, the ascent of lab-grown meat necessitates robust legal and moral guardrails. Ensuring that these products are not just innovative, but also ethically produced, is paramount. Delving into the domain of lab-grown meat, we stand at the brink of uncharted legal landscapes. This unfamiliar territory requires nuanced, forward-thinking regulations to safeguard the public interest, maintain market integrity, and build enduring trust among consumers—all while preserving the cardinal objective of food safety.

However, our engagement with food safety law is not a new challenge. The laws we now take for granted have deep historical roots, shaped and honed by a myriad of global events and evolving societal values.[3] The development of these regulations maps our collective journey from rudimentary measures, born out of urgent crises, to sophisticated frameworks anticipating and addressing potential threats to our livelihood.[4] These laws, in their essence, manifest our

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1 *See* Natalie Brown, *7 Reasons Why Meat is Bad for the Environment*, GREENPEACE (Aug. 3, 2020), https://www.greenpeace.org.uk/news/why-meat-is-bad-for-the-environment/.

2 *See* Chloe Sorvino, *Everything You Need To Know About Lab-Grown Meat Now That It's Here*, FORBES (June 27, 2023, 6:30 AM), https://www.forbes.com/sites/chloesorvino/2023/06/27/everything-you-need-to-know-about-lab-grown-meat-now-that-its-here.

3 *See A Historical Look at Food Safety*, INST. FOOD TECH.: BRAIN FOOD BLOG (Sept. 2019), https://www.ift.org/news-and-publications/blog/2019/september/a-historical-look-at-food-safety [hereinafter INST. FOOD TECH.].

4 *Id.*

society's pledge to protect its members while simultaneously fostering economic growth and innovation within the food industry.[5]

Our current era, with its advanced technological capabilities and global supply chains, is governed by an intricate web of food safety regulations.[6] These laws, shaped by learnings from past successes and failures, serve as the North Star for all food products. As lab-grown meat ventures into the marketplace, its unique characteristics impose a rigorous examination in light of this historical backdrop.[7] The regulatory landscape for food is indeed a complex tapestry woven by various government agencies, each with its own mandates and jurisdictional reach. As lab-grown meat steps into the limelight, identifying the appropriate regulatory bodies, demarcating their roles, and ensuring seamless collaboration among key players will be the bedrock of its successful integration into our everyday diets and markets.

Moreover, the health discourse around both traditional and lab-grown meat is multifaceted, encompassing concerns ranging from microbial contamination to cancer cells.[8] Lab-grown meat, with its controlled-production environment, promises to alleviate many of these issues.[9] However, its novel production techniques may introduce new challenges, making it crucial to dissect, understand, and preemptively address any potential risks to ensure public health remains uncompromised.[10]

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[5] *Id.*

[6] *See* Lone Jespersen et al., *Food Safety Culture Collaboration: Are Regulators Adapting and Catching Up?*, FOOD SAFETY MAG. (Oct. 5, 2023), https://www.food-safety.com/articles/8928-food-safety-culture-collaboration-are-regulators-adapting-and-catching-up.

[7] *See* MEP NAT'L NETWORK, WHAT WE'VE LEARNED FROM THE FDA'S NEW ERA OF SMARTER FOOD SAFETY AND HOW IT WILL IMPACT WHAT'S COMING NEXT 2 (2020), https://www.nist.gov/system/files/documents/2022/02/28/MEP_Report_Food_Safety_FINAL_RVSD.pdf.

[8] What I've Learned, *Lab Meat. The $1 Trillion Ugly Truth*, YOUTUBE (May 14, 2023), https://www.youtube.com/watch?v=V0zCf4Yup34; *Doubts About Safety of Lab-Grown Meat*, THE ORGANIC & NON-GMO REP. (Apr. 4, 2023), https://non-gmoreport.com/doubts-about-safety-of-lab-grown-meat/.

[9] *See Cultivated Meat (It's Science but Not Rocket Science)*, UPSIDE FOODS, https://upsidefoods.com/innovation (last visited Apr. 28, 2025).

[10] Jaydee Hanson & Julia Ranney, *Is Lab-Grown Meat Healthy and Safe to Consume?,* CTR.

Furthermore, the present labeling ecosystem, with its dense regulations, exists to inform and protect consumers.[11] More critically, such regulation reflects the societal demand for transparency and accountability. Within this intricate system, each food product, especially meat, is subject to specific labeling obligations.[12] As lab-grown meat edges closer to supermarket shelves, it is essential to place it properly within the established framework of identification. Equally vital is alignment with modern consumers' expectations, as they now more than ever demand clear and transparent information about what they eat.[13] Restaurants may soon serve as intermediaries between producers and consumers, holding a crucial responsibility to ensure transparency regarding lab-grown meat offerings on their menus.

However, the adage "if something sounds too good to be true, it probably is" serves as a wise reminder to temper our optimism with a healthy dose of reality. Beneath the shiny veneer of this promising industry lies a dark side: an underbelly that warrants scrutiny. While lab-grown meat holds promise for addressing some of the significant challenges posed by traditional livestock farming, a clear-eyed understanding of the potential drawbacks is necessary as the industry scales.[14] The cultivation of lab-grown meat relies heavily on bioreactors and other specialized equipment, often leading to substantial energy expenditure.[15] If the energy sources used to power these pro-

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FOR FOOD SAFETY (Sept. 20, 2020), https://www.centerforfoodsafety.org/blog/6458/is-lab-grown-meat-healthy-and-safe-to-consume.

11 *Food Labeling*, U.S. DEPT. OF AGRIC., https://www.ers.usda.gov/topics/food-choices-health/consumer-information-and-labeling/food-labeling/ (last updated Feb. 4, 2022); *3 Food Safety Labeling Considerations*, BLUE LABEL PACKAGING CO., https://www.bluelabelpackaging.com/blog/3-food-safety-labeling-considerations/ (last visited Apr. 26, 2025).

12 R. POST ET AL., U.S. DEP'T OF AGRIC., A GUIDE TO FEDERAL LABELING REQUIREMENTS FOR MEAT POULTRY AND EGG PRODUCTS 1, 23 (2007), https://www.fsis.usda.gov/sites/default/files/media_file/2021-07/Labeling_Requirements_Guide.pdf.

13 *See From Lab to Label*, A GREENER WORLD (May 5, 2022), https://agreenerworld.org/a-greener-world/from-lab-to-label/.

14 *See* Amy Quinton, *Lab-Grown Meat's Carbon Footprint Potentially Worse than Retail Beef*, UNIV. OF CAL. (May 25, 2023), https://www.universityofcalifornia.edu/news/lab-grown-meats-carbon-footprint-potentially-worse-retail-beef.

15 Danielle Weiner-Bronner, *Meat Without Slaughter: Here's Everything You Need to Know About Lab-grown Meat*, CNN (June 23, 2023, 2:28 PM),

cesses are derived from non-renewable resources, the environmental footprint of lab-grown meat could be drastically larger than anticipated.[16] Further, as lab-grown meat moves toward larger-scale production, there could be significant economic ramifications for traditional farmers and those employed in conventional meat supply chains.[17] While new jobs might emerge within the lab-grown meat industry, this new innovation also threatens to shake the foundations of existing agricultural communities, potentially leading to grave socioeconomic challenges for current farmers.[18]

The emergence of lab-grown meat has cast a spotlight on the potential future of food, yet in the shadows, traditional agricultural giants, commonly known as Big Agriculture (or "Big Ag"), observe the boom with a blend of wariness and opportunism.[19] Big Ag, anchored with its deep roots in supply chains and powerful political lobbies, faces both challenges and opportunities in this shifting landscape.[20] While some powerhouses in the traditional industry view cultured meats as a threat to the established order, others within Big Ag have begun investing in or partnering with start-ups in the lab-grown meat sector, quietly hedging their bets on the future of food.[21] In this push and pull between innovation and tradition, Big Ag's role remains critical, ensuring it is not overshadowed, but rather lurking strategically in the background, poised to emerge at just the right moment.

This Article will explore the intricacies of lab-grown meat, a groundbreaking convergence of science, commerce, and ethics poised to reshape our global food paradigm. Confronting the urgent demand for sustainable food solutions, lab-grown meat presents a tantalizing prospect. Yet, its integration into our diets requires meticu-

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https://www.cnn.com/2023/06/23/business/lab-grown-meat-explainer/index.html.

16 *See* Quinton, *supra* note 14.

17 *How Will Cultured Meat Impact Farming?*, INNOVATION FOR AGRIC. (Mar. 30, 2023), https://www.i4agri.org/news-article/how-will-cultured-meat-impact-farming.

18 *Id.*

19 *Id.*

20 *Id.*

21 *The Big Names Investing in Lab-Grown Meat,* BELIEVER MEATS (Mar. 29, 2023), https://www.believermeats.com/blog/investing-in-lab-grown-meat.

lous navigation through complex legal terrains, health concerns, and socioeconomic implications. Additionally, with the shadow of traditional industry titans looming, the evolution of this sector is inextricably tied to both its potential to disrupt traditional farming and its ability to coexist within the larger agricultural framework. As we move forward, it becomes imperative to tread with informed prudence, ensuring that innovation aligns with considerations of safety, ethical integrity, and sustainability.

II. MEAT REIMAGINED: A PRIMER ON LAB-GROWN MEAT TECHNOLOGY

Lab-grown meat: a dystopian fiction or imminent reality? Once a far-fetched notion, reminiscent of scenes from *The Jetsons*, lab-grown meat is now a tangible entity in the landscape of food production and agriculture. In 2013, the world got its first taste of this innovation with the debut of the lab-grown burger.[22] Many were taken aback not only by its staggering cultivation cost of $330,000 (approximately $457,000 in 2025, accounting for inflation)[23] but also by the precedent it set for the meat industry's evolution.[24] Today, more than 150 companies worldwide are developing cutting-edge technology for lab-grown meat and seafood, totaling over $2.8 billion in investments.[25] However, this seemingly unthinkable technological advancement should not be entirely surprising to those immersed in the world of science. Several decades of accruing scientific knowledge in cell biology, tissue engineering, fermentation technology, and chemical bio-

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22 Elizabeth Barclay, *Long Awaited Lab-Grown Burger is Unveiled in London*, NPR: FOOD FOR THOUGHT (Aug. 5, 2013, 4:00 PM), https://www.npr.org/sections/thesalt/2013/08/05/209163204/long-awaited-lab-grown-burger-is-unveiled-in-london.

23 U.S. INFLATION CALCULATOR, https://www.usinflationcalculator.com/ (last visited Apr. 26, 2025).

24 *See* Barclay, *supra* note 22.

25 William K. Hallman et al., *Cell-Based, Cell-Cultured, Cell-Cultivated, Cultured, or Cultivated. What Is the Best Name for Meat, Poultry, and Seafood Made Directly from the Cells of Animals?* 7 NPJ SCI. OF FOOD 1, 1 (2023), https://www.nature.com/articles/s41538-023-00234-x.

process engineering have logically paved the way for the rise of cultivated meat.[26]

Dressed up with buzzwords such as cultured meat, cellular agriculture, synthetic meat, or tissue-engineered meat, this innovation supposedly heralds a brighter, greener tomorrow. While lab-grown meat comes with a plethora of monikers, all share a single underlying thread: real animal cells. Regardless of the specific categorization, whether beef, seafood, or organ meats, the production process involves the cultivation of cells sourced directly from the animal.[27] Consequently, the continued use of traditional animal-derived methodologies undercuts the perceived novelty of this breakthrough, as it never fully divorces itself from conventional meat production methods.

Furthermore, these cultivated cells are structured to mirror animal tissues, thereby aiming to "replicate the sensory and nutritional profiles of conventional meat."[28] Just as a full-sized cow begins with a single cell, so too does the journey of lab-grown meat.[29] The development of any lab-grown meat entails five primary steps: (1) procuring a biopsy of animal cells; (2) cell banking; (3) cell growth; (4) harvesting; and (5) food processing.[30]

The first step in manufacturing lab-grown meat begins with acquiring "starter cells" from an animal such as a cow, pig, chicken, duck, lamb, or fish.[31] Notably, these starter-cell samples are collected without harming the animal and do not involve the breeding, raising, and slaughtering of animals.[32] The sample is instead obtained by taking a small muscle biopsy or skin sample from a healthy, living ani-

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26 Claire Bomkamp & Elliot Swartz, *The Science of Cultivated Meat*, GOOD FOOD INST., https://gfi.org/science/the-science-of-cultivated-meat (last visited Apr. 26, 2025).

27 *Id.*

28 *Id.*

29 SCOTT F. GILBERT, DEVELOPMENTAL BIOLOGY, Fertilization: Beginning a New Organism, (Sinauer Associates, 6th ed. 2000), https://www.ncbi.nlm.nih.gov/books/NBK10083/.

30 LISA S. BENSON & JOEL L. GREENE, CONG. RSCH. SERV., R47697, CELL-CULTIVATED MEAT: AN OVERVIEW 2 (2023).

31 *The Process: How Is Cultivated Meat Made?*, EDUC. CHOICES PROGRAM, https://www.whatiscultivatedmeat.com/process (last visited Apr. 26, 2025).

32 *Id.*

mal.[33] However, some companies collect the sample after the animal has been slaughtered for traditional meat processing—a method often adopted to comply with dietary laws across a multitude of religions.[34] For the second step, after the starter cells have been obtained, the cells are stored in a cell bank, where the cells undergo internal screening for uniformity and quality.[35] Once verified, the cells are preserved in the bank under cryogenic temperatures and safeguarded until they are required for production. At that point, the cells are transferred into a cultivator where the third step begins: cultivation.[36]

Cultivators, also known as bioreactors, are vessels that provide temperature-regulated, closed environments for cells to multiply as a part of the third step in the process.[37] These bioreactors are equipped with intricate piping that delivers nutrients and removes waste products from the cells, as well as sensor systems that measure oxygen and potential of hydrogen (pH) levels.[38] Inside the bioreactor, the cells quickly duplicate and multiply, turning into mature muscle and fat cells when attached to a solid scaffold—often composed of gelatin and derivatives of plant organisms or fungi.[39] The cells continue to grow until they are ready for the fourth step, harvesting, and later moved to a processing facility. Production takes roughly five to seven weeks, depending on the species and desired end product.[40] In the fifth and final stage, processing, the meat is formed into shapes, such as patties or nuggets, seasoned and packaged, much like traditional meat products.[41] Alternatively, products can be sold as pure cultivat-

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33 *Id.*

34 *Id.*

35 *Id.*

36 *Id.*

37 *The Process: How Is Cultivated Meat Made?*, *supra* note 31.

38 *Id.*

39 *Id.*

40 *Id.*

41 *Id.*

ed meat or mixed with plant additives to create a blended product, texturally similar to ground chicken.[42]

Furthermore, beyond the curiosity of how lab-grown meat is produced, the question remains: how does it taste? In short, lab-grown chicken tastes unmistakably like chicken.[43] Michal Ansky ("Ansky"), a prominent Israeli gastronome and MasterChef Israel judge, participated in a landmark blind taste test that contrasted lab-grown chicken with its traditionally farmed counterpart.[44] This test was conducted at SuperMeat, an Israeli biotechnology company that focuses on developing cultivated meat.[45] Two additional judges joined Ansky, and the event was overseen by lawyers to ensure its authenticity in that the test was truly blind.[46] Both chicken samples were quite similar in appearance, but Ansky was convinced that Sample A was the conventionally raised chicken because of its deeper flavor.[47] Although all the judges noted the relative blandness of both samples, Yair Yosefi, an Israeli chef and restaurateur, detected a distinct difference despite an inability to identify which sample was traditionally farmed.[48] Ansky, by contrast, was certain that Sample B was lab-grown meat due to its subtler taste.[49]

However, when SuperMeat's founder, Ido Savir, revealed that Sample A was, in fact, the lab-grown meat, Ansky was taken aback and challenged the claim.[50] Savir confirmed that Ansky was mistaken, leaving Ansky to publicly concede her error. Ultimately, the taste test reveals that even culinary experts struggle to distinguish lab-grown meat from its traditional counterpart, underscoring the critical

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42 *Id.*

43 Aryn Baker, *Cultivated Meat Passes the Taste Test*, TIME (Jan. 19, 2022), https://time.com/collection-post/6140206/cultivated-meat-passes-the-taste-test/.

44 *Id.*

45 *Id.*

46 *Id.*

47 *Id.*

48 *Id.*

49 Baker, *supra* note 43.

50 *Id.*

importance of regulatory clarity.[51] Furthermore, while this single, blind taste test highlights the potential of lab-grown meat to mimic its traditional counterpart, it hardly settles the broader debate. Factors such as texture, shelf life, cost efficiency, and environmental impact must be comprehensively compared; one taste test alone is insufficient to determine the overall viability and acceptance of cultivated meat in global markets. Setting aside empirical measures, a pressing matter emerges: navigating the intricacies of laws and regulatory frameworks surrounding the production and labeling of lab-grown meat products.

III. LAB-GROWN MEAT: UNDERSTANDING ITS PLACE IN THE REALM OF FOOD SAFETY LAWS AND REGULATORY LANDSCAPE LEGACY

While innovation captivates our attention, we must not allow it to obscure the lessons of history, especially in the context of U.S. food regulations. Although past societies did not have access to advanced, pharmaceutical-grade technologies like the bioreactors used in lab-grown meat production, their dedication to food safety and quality remains evident.[52] Ancient Jewish kosher laws dating back to the thirteenth century BCE serve as an indication of this safety commitment, even if rooted in religious beliefs.[53] Additionally, the history of food regulations can be traced as far back as 1202 CE in Europe.[54] American colonists later recognized the importance of such regulations, enacting their own as early as 1646, laying the foundation for what is recognized as the first U.S. food safety law in 1785.[55]

The first U.S. laws addressing the safety of the American food supply were the Pure Food and Drug Act and the Federal Meat Inspection Act.[56] The former aimed to halt the manufacture and sale of

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51 *Id.*

52 Linda Zeldovich, *What Archaeology Tells Us About the Ancient History of Eating Kosher*, SMITHSONIAN MAG. (May 25, 2021), https://www.smithsonianmag.com/science-nature/what-archaeology-tells-us-about-ancient-history-eating-kosher-180977804/.

53 *See id.*

54 INST. FOOD TECH., *supra* note 3.

55 *Id.*

56 *Id.*; Pure Food and Drugs Act of 1906, Pub. L. No. 59-384, 34 Stat. 768 (1906), *repealed by*

spoiled or incorrectly labeled foods, drugs, medicines, and liquors.[57] The latter prohibited the sale of adulterated meat products and mandated that all meat products be slaughtered and processed under sanitary conditions.[58] In 1949, the Food and Drug Administration ("FDA") published its very first guidance, giving the agency a way to influence industry actions without mandating specific requirements.[59]

Moreover, in 1957, Congress enacted the Poultry Inspection Act.[60] This act mandated the inspection of poultry products entering interstate commerce, serving as a swift response to the growing demand for ready-to-cook foods and other processed poultry items.[61] With various laws being implemented and slightly amended, the 1990s demarcated a pivotal time in American history for food safety laws. In 1997, the FDA Modernization Act made significant changes to the Federal Food, Drug and Cosmetic Act ("FDCA").[62] These pivotal changes expanded the FDA's authority, enabling it to oversee and rigorously regulate claims related to the health and nutrition content on product labels.[63] Additionally, the amendment empowered the FDA to set procedures for substances in new products that come into direct contact with food, such as packaging materials.[64] These changes aimed to ensure not only the safety of products, but also the accuracy of the health and nutritional information presented to consumers.[65] More recently, in 2011, Congress enacted the Food

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Federal Food, Drug, and Cosmetic Act (FDCA), Pub. L. No. 75-717, 52 Stat. 1040 (1938) (codified as amended at 21 U.S.C. §§ 301 et seq.); Federal Meat Inspection Act of 1906, Pub. L. No. 59-382, 34 Stat. 669 (1906) (current version at 21 U.S.C. §§ 601 et seq.).

57 INST. FOOD TECH., *supra* note 3; Pure Food and Drugs Act of 1906.

58 INST. FOOD TECH., *supra* note 3; Federal Meat Inspection Act of 1906.

59 INST. FOOD TECH., *supra* note 3.

60 *Id.*; Poultry Products Inspection Act of 1957, Pub. L. No. 85-172, 71 Stat. 441 (1957) (current version at 21 U.S.C. §§ 451 et seq.).

61 INST. FOOD TECH., *supra* note 3.

62 *Id.*; Food and Drug Administration Modernization Act of 1997, Pub. L. No. 105-115, 111 Stat. 2296 (1997) (amending 21 U.S.C. §§ 301 et seq. (1994)).

63 INST. FOOD TECH., *supra* note 3.

64 *Id.*

65 *Id.*

Safety Modernization Act ("FSMA").[66] This significant piece of legislation shifted the FDA's approach toward a more proactive stance on food safety by emphasizing the importance of taking preventative measures, as opposed to reactionary responses, to various outbreaks caused by food contamination.[67]

As technological advances have surged in the past three years, the U.S. government has been working to determine where lab-grown meat fits in the long lineage of food laws and regulations.[68] The impetus for approving cultivated meat for U.S.-based companies came on the heels of the Singaporean government granting a U.S. company, Eat Just, approval to sell its lab-grown chicken, after receiving authorization from the Singapore Food Agency in 2020.[69] Those in the lab-grown meat industry, including Chief Executive Officer of Eat Just, Josh Tetrick, unsurprisingly, hoped that Singapore's approval would spur the U.S. government to act more swiftly in granting its own approvals.[70]

Despite pressure for prompt action after Singapore's record-breaking announcement, in 2021, the United States had just begun to contemplate how lab-grown meat would fit into the vast landscape of preexisting laws.[71] As U.S. companies made breakthroughs and the demand for regulatory guidance increased, the FDA, using its authority established by its 1949 guidance, set a deadline for receiving public input on the topic of cultivated seafood in March 2021.[72] A few months later, in September 2021, the U.S. Department of Agriculture ("USDA") released a preliminary notice regarding proposed rules for labeling various cultivated meat products and cultivated poultry.[73]

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66 *Id.*; FDA Food Safety Modernization Act, 21 U.S.C. § 2201 (2011).

67 *A Historical Look at Food* Safety, *supra* note 3.

68 *See* GOOD FOOD INST., 2021 STATE OF THE INDUSTRY REPORT: CULTIVATED MEAT & SEAFOOD 56–58 (2021), https://gfi.org/wp-content/uploads/2022/04/2021-Cultivated-Meat-State-of-the-Industry-Report-1.pdf.

69 *See id.*

70 *See* Maxwell Rabb, *Cultured Meat May Be Available in the US Soon. Here's What You Should Know*, THE BEET (June 6, 2022), https://thebeet.com/cultured-meat-us-approval/.

71 *See* GOOD FOOD INST., *supra* note 68, at 56–58.

72 *See id.* at 57.

73 *Id.*

Much like the FDA, the USDA requested public feedback and comments on necessary rules and guidance for proposed labeling.[74]

Predictably, organizations involved in the cultivated meat industry, such as the Good Food Institute ("GFI"), were quick to jump in and push for lax regulation.[75] The GFI submitted a comment advocating for a flexible regulatory approach that would conveniently allow lab-grown meat producers to cloak lab-grown meat products under well-known terms.[76] In its comment, GFI strategically suggested delaying firm technological regulations and waiting until the unsuspecting public had a common understanding of its innovation.[77] This move, arguably, seems less about clarity and more like a sly sidestep of established regulatory norms to secure an advantage.

Concerningly, in this initial governmental solicitation of public feedback on labeling regulations, lab-grown meat and poultry companies sought "to retail their products before the USDA complete[d] the rulemaking process."[78]

After nearly two years of deliberating, in 2023, the FDA completed the market consultation process, declaring lab-grown meat as safe as traditional meat for human consumption.[79] Subsequently, in 2023, the FDA approved lab-grown meat for just two U.S. firms: Good Meat and Upside Foods.[80] However, this limited endorsement, focused solely on these two entities, raises concerns. The FDA's approach, which favors individual company assessments over categorical acceptance, suggests a need for greater prudence when

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74 *Id.*

75 *Id.*

76 *Id.*

77 Letter from the Good Food Institute to the U.S. Food and Drug Admin., Docket No. FDA-2020-N-1720 Request for Information: Labeling of Foods Comprised of or Containing Cultured Seafood Cells (Mar. 8, 2021), https://gfi.org/comment-letters/comment-to-fda-re-request-for-information-on-cultivated-seafood-labeling/.

78 *See* GOOD FOOD INST., *supra* note 68, at 57.

79 Katie Hunt, *Lab-Grown Meat is OK for Human Consumption, FDA Says*, CNN (Nov. 17, 2022), https://www.cnn.com/2022/11/17/health/fda-lab-meat-cells-scn-wellness/index.html.

80 Jared Gans, *First 'Lab-Grown' Meat Approved by Regulators in US*, THE HILL (July 21, 2023), https://thehill.com/policy/energy-environment/4060799-first-lab-grown-meat-approved-by-us-regulators/.

considering the broader implications of this quick and exclusive authorization.[81] With regulatory structures now taking form, it is imperative that we remain highly vigilant and actively engaged in the regulatory process of the lab-grown meat industry.

IV. FUTURE FOODS, PRESENT REGULATORS: THE RIGHT FIT FOR EMERGING NEEDS?

The next piece of the puzzle is determining where lab-grown meat fits into this long lineage of laws and regulations, particularly which entity should take the helm—the FDA or the USDA.[82] At first glance, given the USDA's longstanding mandates and jurisdiction over sectors such as meat, poultry, eggs, and produce, it might seem intuitive that the USDA would regulate this emerging industry.[83] However, this perspective may prove too simplistic. Delving deeper into the regulatory landscape, we must consider the formidable influence of the FDA. After all, this agency has the responsibility of regulating the lion's share of the U.S. food supply; over 80% of our food items, especially those that are processed, fall under the FDA's watchful eye.[84] The FDA's rather extensive purview underscores the agency's deep-rooted expertise and its potential capacity to handle the unique challenges at the frontier of lab-grown meat.

Consequently, the decision regarding the primary regulatory body for lab-grown meat is far from black and white. It requires thoughtful consideration of the strengths, capacities, and historical contexts of both the USDA and the FDA. It is a decision most certainly steeped in nuance and one that requires a holistic approach to ensure both consumer safety and industry clarity. To illustrate this concept, let us consider which agency should regulate a sandwich—more specifically, a packaged sandwich.[85] At first glance, it seems straight-

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81 *See* GOOD FOOD INST., *supra* note 68, at 57.

82 *See id.*

83 Erica Bakota, *FDA vs. USDA: What's the Difference*, GOVLOOP (Aug. 22, 2019), https://www.govloop.com/community/blog/fda-vs-usda-whats-the-difference/.

84 *Id.*

85 *Id.*

forward, but the small detail of whether the sandwich is open-faced or not matters significantly in the analysis.[86] Open-faced sandwiches that contain 50% or more cooked meat by weight fall under USDA regulation because the absence of a second slice of bread makes the meat the primary component.[87] However, sandwiches with two slices of bread, where meat constitutes less than 50% of the sandwich's weight, fall under FDA regulation.[88]

This regulatory scheme is complex enough on its own, but the entrance of lab-grown meat fractures the neat division between USDA and FDA oversight. This raises the question: what happens when the meat in the sandwich is lab-grown and the sandwich is open-faced? The answer lies, perhaps, in the recent 2019 Formal Agreement and subsequent United States Department of Agriculture's Food Safety and Inspection Service ("USDA FSIS") Directives.[89] The 2019 Formal Agreement between the FDA and USDA FSIS delineates a regulatory framework for the oversight of cell-cultured food products in the U.S.[90] This Agreement details the bifurcated responsibilities and collaborative efforts of the two regulatory bodies in supervising both the production and regulation of lab-grown meat.[91]

Further, the Agreement plays a critical role in transitioning responsibilities from the FDA to the USDA FSIS, where each agency has a distinct yet complementary jurisdiction based on the specific stages of cell culturing.[92] Under the Agreement, the FDA's regulatory

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[86] *Id.*

[87] *Id.*

[88] *Id.*

[89] *USDA Updates for Cell-Cultured Meat and Poultry*, FOOD SAFETY NEWS (July 24, 2023), https://www.foodsafetynews.com/2023/07/usda-updates-for-cell-cultured-meat-and-poultry/; U.S. FOOD & DRUG ADMIN. & U.S. DEP'T OF AGRIC., FORMAL AGREEMENT BETWEEN THE U.S. DEPARTMENT OF HEALTH AND HUMAN SERVICES FOOD AND DRUG ADMINISTRATION AND U.S. DEPARTMENT OF AGRICULTURE OFFICE OF FOOD SAFETY (MAR. 7, 2019) [hereinafter FORMAL AGREEMENT]; U.S. DEP'T OF AGRIC., FSIS DIRECTIVE 7800.1, FSIS RESPONSIBILITIES IN ESTABLISHMENTS PRODUCING CELL-CULTURED MEAT AND POULTRY FOOD PRODUCTS (2023) [hereinafter DIRECTIVE 7800.1]; U.S. DEP'T OF AGRIC., FSIS DIRECTIVE 5730.1, RESPONSIBILITIES IN DUAL JURISDICTION ESTABLISHMENTS – REV. 1 (2023) [hereinafter DIRECTIVE 5730.1].

[90] GOOD FOOD INST., CULTIVATED MEAT'S REGULATORY PATHWAY 1 (2023), https://gfi.org/cultivated-regulation-PDF [hereinafter REGULATORY PATHWAY].

[91] *Id.*

[92] *See id.* at 2.

jurisdiction includes pre-harvesting activities, such as cell production, banking, and cultivation for all species.[93] By contrast, the USDA FSIS has jurisdiction over the processing, packing, and labeling of cultivated meat, poultry, and catfish products.[94] However, the FDA retains jurisdiction over the post-harvest process of all other cultivated seafood and cultivated game meat.[95] Under the stipulations of the Agreement, the FDA has instituted a rigorous pre-market consultation protocol, coupled with a mandatory facility registration mandate for producers of lab-grown meat.[96] This process requires each lab-grown meat manufacturer to submit a comprehensive dossier of records and data, ensuring the safety of the manufacturer's products for human consumption.[97] This submission encompasses a thorough examination and evaluation of the entire manufacturing cycle, ranging from cell culture banks to the utilization of binding agents as the meat forms.[98] After the evaluation, the agency publishes the findings of the safety assessment on its official website, ensuring that any proprietary or trade secret information is withheld.[99] Additionally, every lab-grown meat producer is required to register his or her production facilities with the FDA.[100] This registration is mandatory, regardless of the species being cultivated, and it must be completed prior to the commencement of any activities related to the production, processing, packaging, or storage of cultivated meat intended for human consumption.[101] These companies must also conduct an in-depth hazard analysis and implement preventative controls.[102] The FDA is then responsible for conducting regular inspections at all registered

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93 *Id.* at 1.

94 *Id.* at 1.

95 *Id.* at 2.

96 REGULATORY PATHWAY, *supra* note 90, at 1; FORMAL AGREEMENT, *supra* note 89.

97 REGULATORY PATHWAY, *supra* note 90, at 1.

98 *Id.*

99 *Id.* at 2.

100 *Id.*

101 *Id.*

102 *Id.*

lab-grown meat production facilities to ensure ongoing compliance and uphold safety standards for human consumption.[103]

Under the Agreement, regulatory oversight transitions from the FDA to the USDA FSIS at the point of cell harvest from cultivators.[104] After the harvesting phase, the USDA assumes the responsibility of supervising the processing, packaging, and labeling of the lab-grown meat, ensuring compliance with standards necessary for human consumption and labeling standards.[105] Mirroring the protocol for traditional meat processing establishments, lab-grown meat companies must secure a USDA inspection authorization prior to initiating production, distribution, or sales.[106] This endorsement is contingent upon a preliminary, in-person audit by the USDA, designed to verify conformity with regulatory requirements.[107] Lab-grown meat facilities are subject to the same regulatory framework as traditional meat facilities, covering criteria such as facility construction specifications, operational protocols, and comprehensive record-keeping.[108]

Following the grant of inspection, the USDA maintains attentive oversight, conducting periodic follow-up inspections at intervals consistent with those that apply to conventional meat processing facilities.[109] Ultimately, the Agreement underscores the importance of harmonized interagency cooperation, establishing a precedent for future collaborative regulatory efforts in the rapidly evolving field of food technology.[110] The careful partitioning of responsibilities and the establishment of clear jurisdictional boundaries between the FDA and USDA FSIS in the Agreement marks a paradigmatic shift in the lab-grown meat industry, paving the way for enhanced safety, effica-

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103 REGULATORY PATHWAY, *supra* note 90, at 2.

104 *Id.* at 3.

105 *Id.*

106 *Id.*

107 *Id.*

108 *Id.*

109 REGULATORY PATHWAY, *supra* note 90, at 3.

110 *See id.*

cy, and transparency in the burgeoning sphere of cell-cultured food products.[111]

As a part of operationalizing the joint regulatory approach outlined in the 2019 Formal Agreement, in June 2023, the USDA FSIS unveiled new Directives and a Notice concerning the oversight of food products made from cell lines of species within USDA's jurisdiction.[112] The fresh directives, specifically Directive 7800.1, Directive 5730.1, and Notice 31-23, shape inspection protocols, sampling methods, and duties of facilities that manufacture meat and poultry products derived from cell cultures, or lab-grown meat.[113] Specifically, Directive 7800.1 provides essential guidance for FSIS inspectors.[114] It meticulously outlines how they should approach establishments that have ventured into the relatively new arena of producing cell-cultured, or lab-grown, meat and poultry intended for human consumption.[115]

This is significant because it recognizes the evolving landscape of meat production and ensures adherence to safety and quality standards beyond traditional farming methods. [116] The Directive also emphasizes collaborative efforts between the USDA FSIS and the FDA.[117] Both bodies have vital roles in regulating this industry, with a clear delineation of duties.[118] The FDA is primarily responsible for overseeing the initial stages of production, specifically before the meat is harvested.[119] Once the meat is harvested, FSIS takes the lead, ensuring that everything that happens post-harvest aligns with exist-

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111 *See* Deepti A. Kulkarni, *The Age of Innovation In Food: Is Our Regulatory System Ready?*, 80 MD. L. REV. ONLINE 41, 45 (2021).

112 *USDA Updates for Cell-Cultured Meat and Poultry*, *supra* note 89.

113 DIRECTIVE 7800.1, *supra* note 89; DIRECTIVE 5730.1, *supra* note 89; U.S. DEP'T OF AGRIC., FSIS NOTICE 31-23, UPDATED-CELL-CULTURED MEAT AND POULTRY FOOD PRODUCTS SAMPLING PROGRAM (2023) [hereinafter NOTICE 31-23]; Bakota, *supra* note 83.

114 DIRECTIVE 7800.1, *supra* note 89.

115 *See generally id.*

116 *USDA Updates for Cell-Cultured Meat and Poultry*, *supra* note 89.

117 *Id.*

118 *Id.*

119 *Id.*

ing regulations.[120] This ensures continuity in the regulatory process and emphasizes that cell-cultured meat, despite its unique production method, is held to the same rigorous standards as conventionally-sourced meat.[121]

Directive 5730.1 addresses situations where establishments may be regulated by both USDA FSIS and FDA, termed "dual jurisdiction."[122] This directive was spurred by an updated Memorandum of Understanding between the regulatory bodies, acknowledging the complexities of food production, particularly in the cell-cultured meat sector.[123] Key updates include streamlined inter-agency communication, clear role definitions to prevent overlap, and precise identification of establishments under both USDA FSIS and FDA oversight.[124] Notice 31-23 supersedes its predecessor, Notice 27-23, and carries a specific emphasis on the sampling of ready-to-eat cell-cultured meat products.[125] Yet, as the industry evolves, so do the methods of ensuring product safety and quality.[126]

Notice 31-23 provides granular details, equipping inspection personnel with a comprehensive guide on how to systematically collect samples from establishments in the cell-cultured meat sector.[127] The backdrop of this notice is the joint regulatory oversight by the FDA and USDA FSIS.[128] While both agencies have a stake in ensuring the quality of cell-cultured meat, post-harvest stages, such as inspections and testing of the final products, fall within the domain of the USDA

120 *Id.*

121 *Id.*

122 DIRECTIVE 5730.1, *supra* note 89.

123 *Id.*

124 *See generally id.*

125 NOTICE 31-23, *supra* note 113.

126 Dave Fusaro, *Food Safety 2024: Can FDA and USDA Keep Up?,* FOOD PROCESSING (Feb. 1, 2024), https://www.foodprocessing.com/food-safety/article/33036207/food-safety-2024-can-fda-and-usda-keep-up.

127 NOTICE 31-23, *supra* note 113.

128 *Id.*

FSIS.[129] This specialized focus ensures that even as the food industry innovates, food safety remains paramount.[130]

Considering the concurrent roles and overlapping regulation of the FDA and USDA in overseeing the burgeoning lab-grown meat industry, another pertinent question arises: could the establishment of a distinct, specialized governmental entity solely focused on lab-grown meat amplify the effectiveness and accuracy of regulatory oversight? For example, this concept mirrors the recent Senate proposal for a new artificial intelligence regulatory body, serving as a potential model for emerging industries that are highly technical and new, such as lab-grown meat.[131] Such a specialized approach in the lab-grown meat sector could demonstrate the advantages of streamlined regulation over the current scenario of overlapping agency jurisdictions.

However, while federal regulations are undeniably crucial in safeguarding consumer safety, economic pitfalls can emerge when agencies like the FDA and USDA concurrently regulate the same domain.[132] This redundant oversight often leads to operational inefficiencies, presenting considerable challenges to American businesses and industries.[133] The duplication in regulation typically incurs superfluous costs stemming from repetitive inspections and bureaucratic processes.[134] Furthermore, divergent enforcement by different agencies engenders inconsistent standards and perplexing industry expectations.[135] The existing food manufacturing regulatory framework already exemplifies the burdens and inefficiencies of such an approach, leading to policy ambiguity and reduced market competi-

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129 *Id.*

130 *USDA Updates for Cell-Cultured Meat and Poultry*, *supra* note 89.

131 Brian Fung, *US Senator Introduces Bill to Create a Federal Agency to Regulate AI*, CNN (May 18, 2023), https://www.cnn.com/2023/05/18/tech/bennet-digital-regulator-bill-ai-provisions/index.html.

132 *Overlapping Agency Jurisdiction*, BUS. ROUNDTABLE, https://www.businessroundtable.org/policy-perspectives/smart-regulation/overlapping-agency-jurisdiction (last visited Apr. 26, 2025).

133 *Id.*

134 *Id.*

135 *Id.*

tiveness.[136] It is imperative to recognize that state and local regulations could compound the strains on industries already grappling with excessive regulatory overlap and constraints.[137] Proactively addressing and circumventing these potential duplications, particularly in emerging sectors like lab-grown meat, is essential.[138] Such foresight enables U.S. businesses to sustain their global innovation leadership, thereby fostering sustainable, long-term economic growth that benefits the entire nation.[139] In navigating the dense regulatory thicket that overshadows the food manufacturing landscape, it is crucial to regard the consumer base not as a passive recipient but as a pivotal force.[140] The ascendancy of lab-grown meat and similar emerging markets is contingent not only upon regulatory compliance but, more fundamentally, on consumer confidence and demand.[141] The most advanced and streamlined regulatory framework imaginable still remains at the discretion of consumer sentiment.[142] Those who occupy the final link in the supply chain possess a formidable influence over the prosperity of innovative endeavors such as lab-grown meat. Their stipulations for safety, excellence, and ethical transparency are the cornerstones upon which the success of these modern industries will rest. Building on the need for transparency and consumer education, the way lab-grown meat is named and labeled becomes a crucial aspect of shaping public perception.[143]

As regulatory discussions about labeling requirements for lab-grown meat neared a conclusion toward the end of 2023, it is nonetheless still important to consider how these decisions will impact

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136 *Id.*

137 *Id.*

138 *Overlapping Agency Jurisdiction*, *supra* note 132.

139 *Id.*

140 *See* Lívia Garcez de Oliveira et al., *Consumers' Attitudes Towards Lab-Grown Meat, Conventionally Raised Meat and Plant-Based Protein Alternatives*, 99 FOOD QUALITY & PREFERENCE 2 (2022).

141 *See id.*

142 *See id.*

143 *See Labeling Lab-Grown "Meat"*, A GREENER WORLD (Oct. 25, 2023), https://agreenerworld.org/a-greener-world/labeling-lab-grown-meat/.

consumer expectations and trust in this innovative food category.[144] The use of terms such as "cell-cultured protein" in place of general "meat" or "poultry" labels is a significant aspect of this discussion. Consumers expect that the labeling agency, the USDA, will provide clarity to consumers, ensuring that consumers are fully aware of what they are purchasing, as the agency creates labeling regulations and incorporates uncustomary language and terminology.[145] Consumers seek a labeling approach that prioritizes transparency, empowering them to make informed choices between lab-grown and traditional, farm-raised meat options.[146] Such disclosures enable the consumer to make informed moral, environmental, and health choices and should therefore be mandatory.

Further, the concept of having product information prominently displayed on the packaging—rather than accessible only through QR codes, as some producers suggest—supports transparency and accessibility, particularly for consumers without smartphones, internet, or digital fluency. Moreover, acknowledging the significant sway that consumers have in the fate of lab-grown meat, a recent study sought to examine the nuances of public opinion in this area.[147] The research illuminated the various degrees of consumer reluctance and the underlying attitudes that could either propel or hinder the acceptance of such innovative food products.[148] Evidently, there lies a critical concern among consumers regarding the ecological ramifications of traditional meat production, spurring a wave of interest in alternative protein sources.[149] Within this context, lab-grown meat has entered the conversation as a potential solution.[150]

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144 *Id.*

145 *See USDA Enforces "Product of USA" Label Clarity*, FARMS (Mar. 14, 2024), https://m.farms.com/ag-industry-news/usda-enforces-product-of-usa-label-clarity-309.aspx.

146 *See Food Safety Advocates Call for Regulation and Transparent Labeling of Cell-Culture Lab 'Meats'*, CTR. FOR FOOD SAFETY (Dec. 3, 2021), https://www.centerforfoodsafety.org/press-releases/6524/food-safety-advocates-call-for-regulation-and-transparent-labeling-of-cell-cultured-lab-meats.

147 Garcez de Oliveira et al., s*upra* note 140, at 1.

148 *See id.* at 2.

149 *Id.* at 3.

150 *Id.* at 1.

However, it appears that consumer sentiment does not uniformly favor this innovation.[151] When evaluating various aspects such as health, safety, affordability, eating enjoyment, animal welfare, and environmental impact, the study suggests that lab-grown meat falls short of plant-based alternatives.[152] Yet, consumers appear to maintain confidence in the health and economic benefits of traditional poultry while expressing reservations about the nascent lab-grown meat sector.[153] In the critical domains of animal welfare and environmental conservation, lab-grown meat, while potentially offering improvements over conventional meat production, does not inspire as much consumer optimism as plant-based options.[154] The findings indicate that despite the innovative promise of lab-grown meat to revolutionize the food industry, there is a tangible hesitancy among consumers that could hinder its widespread adoption.[155]

V. FROM LAB TO LABEL: HOW CONSUMERS INTERPRET MEAT ALTERNATIVES

In the context of health concerns, there is a noticeable apprehension among consumers regarding the healthfulness of lab-grown meat compared to traditional meat products and plant-based meat products.[156] This reticence may be rooted in a general unfamiliarity with lab-grown meat production methods.[157] A sizable portion of the public harbors doubts about its nutritional value, perceiving it as an unnatural food product.[158] Such a view could potentially lead to the assumption that lab-grown meat, being a product of scientific engi-

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151 *See id.* at 7.

152 *Id.* at 8.

153 Garcez de Oliveira et al., s*upra* note 140, at 5.

154 *See id.* at 6.

155 *Id.* at 5.

156 *Id.* at 7.

157 *Id.* at 2.

158 *Id.* at 5.

neering rather than traditional farming, might not align with their standards of a healthy diet.[159]

Further, the market's perception of lab-grown meat is that it sits at a higher price point, a belief likely influenced by the notion that most novel technologies carry a premium.[160] Consumers may not be fully aware of the economies of scale that could make lab-grown meat more cost-effective in the long run, or how advances in technology could eventually reduce production costs.[161] This lack of clarity contributes to the perception that lab-grown meat, as a product of sophisticated scientific endeavor, will remain out of reach for the average consumer due to cost.[162] Moreover, safety considerations are always at the forefront when it comes to the adoption of new food technologies.[163] Among consumers, a significant degree of hesitation persists regarding lab-grown meat, stemming from limited information about its long-term health impacts and the regulatory frameworks governing its production.[164] The innovative nature of lab-grown meat production raises questions and concerns that can only be assuaged through rigorous testing and transparent communication of safety standards.[165]

Additionally, the enjoyment derived from eating meat, particularly its taste and texture, plays a vital role in consumer satisfaction with their food choices.[166] Lab-grown meat is currently battling against a tide of skepticism regarding its ability to provide a culinary experience on par with traditionally-sourced meats.[167] The belief that lab production cannot replicate the sensory pleasures of meat may lead to greater reluctance among consumers to embrace lab-grown

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159 Garcez de Oliveira et al., s*upra* note 140, at 7.

160 *See id.* at 3.

161 Greg L. Garrison et al., *How Much Will Large-scale Production of Cell-Cultured Meat Cost?*, 10 J. AGRIC. & FOOD RSCH. 1, 2, 7 (2022).

162 Garcez de Oliveira et al., *supra* note 140, at 3.

163 *Overlapping Agency Jurisdiction*, *supra* note 132.

164 Nicolas Treich, *Cultured Meat: Promises and Challenges*, 79 ENV'T & RES. ECONS. 33, 40, 42–43, 52 (2021).

165 *See Overlapping Agency Jurisdiction*, *supra* note 132.

166 Garcez de Oliveira et al., *supra* note 140, at 2–3.

167 *Id.* at 5.

meat.[168] If the public remains unconvinced about the culinary merits of lab-grown meat, the path to widespread acceptance may be significantly obstructed.[169]

However, the perceived "unnaturalness" of lab-grown meat appears to be the primary source of consumer discomfort.[170] This is often due to the psychological phenomenon known as "neophobia," which is the fear of anything new or unfamiliar.[171] In the context of food, this can manifest as a disinclination to try products that are perceived as artificial or synthetic.[172] Moreover, there is a strong cultural and emotional connection to food and eating, with traditional meat consumption being deeply ingrained in many societies.[173] Lab-grown meat challenges these traditions, generating discomfort among consumers who value the natural origins and traditional processing of their food.[174]

For consumers to overcome these barriers, it is essential for lab-grown meat producers and marketers to build public trust through transparency, education, and by addressing these concerns head-on.[175] This could include providing clear information about the health benefits, safety standards, and affordability of lab-grown meat, as well as offering tastings to assure consumers about its palatability.[176]Additionally, emphasizing the ethical and potential environmental advantages of lab-grown meat, without overshadowing the direct consumer benefits, could help shift perceptions in a positive direction.[177] Overall, the research reveals that the industry has many

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168 *Id.* at 5, 8.

169 *Id.*

170 Michael Siegrist et al., *Perceived Naturalness and Evoked Disgust Influence Acceptance of Cultured Meat*, 139 MEAT SCI. 213, 213–14 (2018).

171 Robert Hamlin et al., *Food Neophobia, Food Choice and the Details of Cultured Meat Acceptance,* 194 MEAT SCI. 3 (2022), https://www.sciencedirect.com/science/article/pii/S0309174022002327.

172 *See id.* at 3.

173 *Id.* at 2.

174 Siegrist et al., *supra* note 170, at 215.

175 Garcez de Oliveira et al., *supra* note 140, at 8.

176 *Id.*

177 *Id.*

miles to go until it reaches its destination of consumer satisfaction and trust.

VI. A WORD ON NOMENCLATURE: CONSUMER INSIGHTS AND REGULATORY ALIGNMENT

As this new food category emerges, there is an increasing recognition within the industry of the dire consequences linked to the act of naming its products. A name is not merely a label, but a gateway to acceptance or rejection—a chess game within the minefield of regulatory compliance and consumer trust. FDA rules (21 C.F.R. § 101.3) and USDA standards for meat (9 C.F.R. § 317.2) and poultry (9 C.F.R. § 381.117) require the use of "common or usual names" to inform consumers about the nature of their food products.[178] If the U.S., and other international companies attempting to sell within the U.S., want to receive regulatory approval, a commonly-accepted term is necessary to label and market their products.[179]

When the FDA requested public comments on the appropriate labeling nomenclature for cell-cultivated products, the public's call for transparency was more than a mere whisper. An overwhelming majority of respondents had a pronounced preference for the FDA to require product identity language that would unequivocally set apart cell-cultured products from their traditional counterparts. [180] Most companies in the industry prefer the terms "cell-cultured" or "cell-based" for seafood, terms that have garnered endorsement from the leading producers involved in cell-based meat and poultry sectors.[181] These leaders and producers are championing the adoption of a singular term to facilitate international trade and achieve a cohesive regulatory structure.[182] Additionally, producers are advocating for the consistent use of a single term to describe and label their prod-

178 21 C.F.R. § 101.3 (2024) (FDA regulations); 9 C.F.R. § 317.2 (2024) (USDA meat regulations); 9 C.F.R. § 381.117 (2024) (USDA poultry regulations); William K. Hallman et al., *supra* note 25, at 1.

179 William K. Hallman et al., *supra* note 25, at 2.

180 *Id.* at 1.

181 *Id.* at 2–3.

182 *Id.* at 2.

ucts, intending to achieve a more transparent market and favorable public perception.[183] A unified term would serve as a basis for clear communication, ensuring that consumers have a consistent and straightforward understanding of the food products, thereby fostering acceptance and informing buyers.

While consumer acceptance and perception are fundamentally linked to the industry's success, market leaders must perform a careful balancing act to satisfy consumers while simultaneously complying with the stringent regulatory requirements for product nomenclature. If names are chosen with only marketing in mind, producers run the risk of violating FDCA's mandate that all labeling must be truthful and not misleading under 21 U.S.C. § 343(a).[184] Furthermore, a recent study of nearly 5,000 American adults attempted to navigate competing interests and articulated a test that companies must meet to avoid the specter of public distrust and legal retribution. The research findings suggest that there are five total criteria for naming the products that can pass both the regulatory test and the consumer-preference test—two criteria for regulations and three criteria for consumers.[185] To pass the regulatory test, the term must (1) "distinguish the novel products from conventional products;" and (2) "appropriately signal allergenicity" meaning it must disclose any allergy-causing elements.[186] To pass the consumer-preference test, the term for cell-based meat must be seen as (1) "appropriate;" (2) the term must not "disparage the novel or conventional products;" and (3) the term "must not elicit perceptions that the products are unsafe, unhealthy, or not nutritious."[187]

Looking at the regulatory test, the first criterion should enable consumers to distinguish cell-based products from conventionally-produced products.[188] FDA regulations (21 C.F.R. § 101.3) and USDA

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183 *Id.*

184 21 U.S.C. § 343(a).

185 William K. Hallman et al., *supra* note 25, at 2.

186 *Id.*

187 *Id.*

188 21 C.F.R. § 101.3 (2024) (FDA regulations); 9 C.F.R. § 317.2 (2024) (USDA meat regulations); 9 C.F.R. § 381.117 (2024) (USDA poultry regulations); William K. Hallman et al., *supra* note 25, at 2.

regulations for meat (9 C.F.R. § 317.2) and poultry products (9 C.F.R. § 381.117) require that producers use common, or usual, names to inform consumers about the identity of their food products, effectively safeguarding the public from being misled.[189] The data indicates that labeling cell-cultured products as "Cell-Based", "Cell-Cultured", and "Cell-Cultivated" more effectively differentiates those products from conventional meat products.[190] On the contrary, simpler terms consisting only of "Cultivated" and "Cultured" were less clear, leading to ambiguity regarding the products' origins, thereby failing to pass muster with regulatory standards.[191] In essence, "cell-" prefixed terms instilled consumer confidence in recognizing that the product was not a conventional meat product.[192]

Moreover, the second criterion in the regulatory test delineates that the term should communicate any potential allergen.[193] Despite the innovative origins of cell-based meat, poultry, and seafood, the products inherently contain identical allergenic proteins found in traditional products; thus, the labeling criteria do not change between traditional meat products and cell-based products.[194] The Food Allergen Labeling and Consumer Protection Act of 2004 ("FALCPA") requires that foods containing a protein from a major food allergen must prominently display the allergen's presence on its label.[195] Specifically for seafood, a sector where nearly 3% of Americans face allergic reactions, FALCPA goes further to insist on the disclosure of the exact species.[196] Notably, allergen information is not as prominently displayed on the label as it could be, negating the intent of the

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189 Comments of the National Cattlemen's Beef Association on Labeling of Meat or Poultry Products Comprised of or Containing Cultured Animal Cells, 86 Fed. Reg. 49491, to U.S. Dep't of Agric. (Dec. 1, 2021), https://orcattle.com/wp-content/uploads/2021/12/NCBA-Comments-RE-USDA-Cell-Culture-ANPR.pdf.

190 William K. Hallman et al., *supra* note 25, at 1, 11.

191 *Id.*

192 *Id.* at 9, 11–12.

193 *Id.* at 2.

194 *Id.*

195 *Id.*

196 William K. Hallman et al., *supra* note 25, at 2.

very warning itself.[197] This oversight is critical for cell-based seafood products considering that products labeled "Cultivated" were perceived as the least safe for allergic individuals to consume. [198] Undoubtedly, inaccuracies in labeling could precipitate outcomes far more serious than mere market rejection.

Separate from the regulatory test, the gauge for consumer receptivity rests on three main criteria for approval.[199] The first of these criteria assesses whether various terms used to describe cell-cultured products were deemed appropriate by survey participants.[200] Remarkably, more than half of the participants reported being unfamiliar with cell-based meat production processes, indicating a significant lack of awareness concerning this emerging group of products.[201] In this context, the term "Cultivated" failed to inspire confidence when compared to "Cell-cultivated" and "Cell-based" in terms of appropriateness.[202]

Analysis of the second criterion, disparagement, in the consumer test revealed that reactions to the product packaging language were generally positive across the range of terms, with none serving to disparage the products.[203] Specifically, the terms "Cultivated" and "Cultured" were met with as much favor as "Cell-based" and "Cell-cultured," with "Cell-cultivated" being the least positively perceived.[204] This outcome suggests that while the "Cell-" prefix might imply a more scientific or technical product, it does not necessarily lead to negative perceptions among consumers.[205]

The third criterion analysis, avoiding false perceptions, revealed that all terms were considered moderately safe by survey respond-

197 *Id.*

198 *Id.* at 6.

199 *Id.* at 11.

200 *Id.*

201 *Id.* at 4.

202 William K. Hallman et al., *supra* note 25, at 8–9.

203 *Id.* at 2.

204 *Id.* at 5.

205 *See id.*

ents.[206] Unsurprisingly, regarding naturalness, products with "Cell-" prefixes were perceived as less natural and more likely to be genetically modified than those simply labeled "Cultivated" or "Cultured."[207] Despite these nuances, consumer perceptions of nutrition and health remained consistent across all terminologies; all product terms were seen as moderately nutritious and neither particularly healthy nor unhealthy.[208] Taste perceptions showed minor variations, with "Cultured" products rated as tasting better than "Cell-based" products.[209] Overall, the research indicates that while the naming of cell-cultured products can slightly sway consumer perceptions, it does not significantly skew perceptions toward negative or inaccurate assumptions about the products.[210]

The gravitas of nomenclature is not just critical but existential. Insights from the study point to a disturbing gap in consumer knowledge regarding cell-cultured meat, with a significant majority being strangers to the concept itself.[211] This lack of awareness highlights the importance of selecting a common or usual name that not only informs but also clearly communicates, the basic nature and distinguishing characteristics of these products. The research also reveals that in the absence of specific labels, consumers tend to resort to default assumptions about the product's nature and origin.[212] This proclivity underscores the critical role of precise labeling in shaping consumer perceptions correctly, dispelling myths surrounding these emerging products. In conclusion, the study not only highlights the importance of precise nomenclature by suggesting "Cell-cultured" as the frontrunner for terminology, but it also exposes a profound need for consumer education. If the lack of understanding goes unaddressed, there could be widespread rejection and a troubled future for lab-grown meat products.

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206 *Id.* at 6.

207 *Id.*

208 William K. Hallman et al., *supra* note 25, at 6.

209 *Id.*

210 *Id.* at 10.

211 *Id.* at 4.

212 *Id.* at 9

VII. THE ILLUSION OF GREEN: PROBING THE SCALABILITY AND SUSTAINABILITY PARADOX OF LAB-GROWN MEAT

The deep dive into the naming of cell-cultured meats uncovers a sobering consideration: would the level of consumer and regulatory approval change if the full environmental ramifications of lab-grown meat production were widely understood? Although "Cell-cultured" has emerged as the preferred term, which satisfies both regulatory and consumer criteria,[213] it is worth considering whether this acceptance would endure if the potential, catastrophic ecological shadows cast by lab-grown meat production were fully illuminated.

As we shift from conceptual frameworks to tangible products, the lab-grown meat industry faces a daunting challenge. It must navigate the tightrope between advocating for a potentially more sustainable alternative to traditional livestock farming while acknowledging the grim possibility that this technological leap could lead to unforeseen ecological crises. The industry's capacity to convey these stark realities will be pivotal in shaping the future of cell-cultured meats, potentially determining whether they are embraced as a symbol of hope or condemned as a marker of environmental decline.

A recent University of California at Davis ("UC Davis") study examined the environmental implications of animal cell-based meat or cultured meat production.[214] The study focused on how feasible economically friendly and environmentally friendly lab-grown meat is in comparison to conventional livestock meat.[215] This study is based on findings from techno-economic and life cycle assessments of the growth media needed to form the lab-grown meat over time.[216] To understand the ramifications of lab-grown meat, it is essential to compare the new technology against the backdrop of traditional farming and meat demand over the past several years. Global meat production has risen from 70.57 million tons in 1961 to 337.18 million

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213 *Id.* at 11.

214 Derrick Risner et al., *Environmental Impacts of Cultured Meat: A Cradle-to-Gate Life Cycle Assessment,* 5 ACS FOOD SCI. TECH. 61, 64 (2024), https://pmc.ncbi.nlm.nih.gov/articles/PMC11744764/pdf/fs4c00281.pdf.

215 *Id.* at 64.

216 *Id.* at 61.

tons in 2020, with beef and buffalo comprising approximately 22% of global meat production, [217] while poultry and pork account for approximately 39% and 32% respectively.[218] By 2050, meat demand is expected to double, raising environmental concerns, particularly concerning beef, which has the highest environmental impact per kilogram among all livestock under current livestock processing methods.[219]

It is well-established that the environmental impact of beef production is substantial, given that traditional beef production results in greenhouse gas emissions, nutrient loading, biodiversity loss, and deforestation.[220] For example, beef life cycle assessments indicate a carbon dioxide equivalent range of 7.6 to 29.7 kilograms per kilogram of beef, varying significantly with production systems and geographies.[221] While lab-grown meat producers claim to reduce environmental impact, studies suggest that this promise may be hollow, or even fundamentally misleading.[222] Indeed, studies cast doubt on the ambitious claims, suggesting any real environmental benefits will be realized only in the very distant future.[223]

Currently, there are not enough bioreactors commercially available at a large scale to make lab-grown meat a common market item.[224] These early machines are borrowed from biopharmaceutical industries, which have been known to be historically energy-intensive.[225] The total environmental impact is measured using life cycle assessments, considering all energy, water, and materials needed.[226] Addi-

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217 *Id.*

218 *Id.*

219 *Id.*

220 Risner et al., *supra* note 214, at 62.

221 *Id.*

222 *Id.* at 71.

223 *Id.* at 71–72.

224 Casey Crownhart, *Here's What We Know About Lab-Grown Meat and Climate Change*, MIT TECH. REV. (July 3, 2023), https://www.technologyreview.com/2023/07/03/1075809/lab-grown-meat-climate-change/.

225 *Id.*

226 *Id.*

tionally, a recent study by Edward Spang, a researcher at the College of Agricultural and Environmental Sciences for UC Davis, estimates that the global warming potential ("GWP") of cultivated meat has several different outcomes under various scenarios.[227] Current biopharmaceutical-like processes, which remain the only available technology, produce between 250 and 1000 kilograms of carbon dioxide per kilogram of meat. However, if companies switch to more standard food-grade processes that produce 10 to 75 kilograms of carbon dioxide per kilogram of meat, the product's emissions profile then becomes lower than that of conventional beef.[228] Nonetheless, this does not address the full environmental impact. There is a high-purity ingredient requirement accompanied by an intense purification process in the production of lab-grown meat.[229]

Moreover, one of the major hurdles that lab-grown meat producers must overcome is endotoxin removal.[230] While the endotoxin process necessarily removes bacteria that affect cell culture and prevents contamination, the removal of endotoxins in the bioreactors is extremely resource-intensive, significantly impacting the environmental cost.[231] Notably, previous life cycle assessments lack reliability due to high uncertainty and the omission of factors such as endotoxin removal, which likely underpins the claims and assumptions made by multibillion-dollar companies in the industry.[232]

However, the data presents a stark reality.[233] Studies reveal that greenhouse gas emissions for lab-grown meat production range from 19.2 to 1508 kilograms of carbon dioxide per kilogram of lab-grown meat.[234] This figure is significantly higher than the minimum reported GWP for retail beef, which is 9.6 kilograms of carbon dioxide per

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227 *Id.*

228 *Id.*

229 *Id.*

230 Risner et al., *supra* note 214, at 71.

231 Crownhart, *supra* note 224.

232 *See* Risner et al., *supra* note 214, at 71.

233 *See id.* at 69.

234 *Id.*

kilogram of traditional meat.[235] Moreover, in scenarios involving a purified growth medium, the GWP ranges from 4 to 25 times higher than the median GWP of retail beef—60 kilograms of carbon dioxide per kilogram. These numbers reveal a startling truth, illustrating that lab-grown meat production is significantly more resource-intensive than most meat production systems due to bioreactors.[236] Currently, most bioreactors used for lab-grown meat are fossil-fueled—a dependency that remains, for now, nearly impossible to avoid.[237]

While the study's findings contest the perception that lab-grown meat is greener than traditional agriculture practices, this contradiction points to a dire need for technological advancement in the field. The research highlights the need for technological advancements such as endotoxin-resistant cell lines or more eco-friendly purification methods before lab-grown meat becomes a viable alternative to traditional meat.[238] In terms of greenhouse gas emissions and fossil fuel depletion, lab-grown meat is more environmentally taxing than traditional meat, further contradicting previous studies suggesting otherwise.[239] Additionally, the lack of scalable data obscures the true climate impacts of cultivated meat.[240] As companies begin to scale up their production of lab-grown meat, more comprehensive data will shed light on the long-term environmental footprint.[241] This growing sector aims to transition from the costly, biopharmaceutical standards to more sustainable methods; yet, this shift remains slow and incomplete. Thus, the promise that lab-grown meat can deliver climate benefits poses more uncertainties than it resolves, ensuring it remains a subject of ongoing research and scientific debate.

Moreover, the expansion of lab-grown meat faces formidable hurdles that stretch beyond the laboratory bench. The scalability issue encompasses a spectrum of biological and technical challenges,

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235 *Id.* at 67.

236 *Id.* at 70.

237 Crownhart, *supra* note 224.

238 Risner et al., *supra* note 214, at 70–71.

239 *Id.* at 70.

240 *See id.* at 71–72.

241 *See id.* at 64.

steep operational costs, and the exorbitant price of raw materials, which altogether casts doubt on its economic feasibility and mass-market potential.[242] Biological constraints, such as the inherently slow proliferation rate of animal cells compared to their microbial counterparts, metabolic inefficiencies, and the cells' sensitivity to stressors within bioreactors hinder the viable volume and density of cell cultures.[243] Likewise, the accumulation of cellular waste byproducts, such as ammonia, further complicates the culture process, presenting yet another concern for cell viability.[244] Additionally, the capital costs for equipment and facilities are prohibitively high mainly due to the stringent sterility requirements. For example, one bioreactor system alone can cost approximately $1.5 million to purchase.[245] Further, the operating costs of these bioreactors, which include consumables, utilities, and labor, add significantly to the overall production cost with the estimated cost landing around a staggering $37 to $51 per kilogram. [246]

In addition, producers face scalability issues due to raw material expenses.[247] The cost of the amino acids and protein growth factors, also known as media components, contribute substantially to the overall cost of lab-grown meat production.[248] In a compounding manner, the media components are not being constructed at a scale large enough to support food production, as the components themselves have a hefty price tag.[249] To become economically viable and competitive with traditional meat, the production cost of lab-grown meat must be reduced to around $25 per kilogram.[250] However, current production expenses exceed this threshold by a wide margin, posing significant viability challenges. Although research is under-

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242 David Humbird, *Scale-Up Economics for Cultured Meat*, 118 BIOTECH. & BIOENG'G 3239, 3239 (2021).

243 *Id.*

244 *Id.*

245 *Id.*

246 *Id.*

247 *Id.* at 3245.

248 Humbird, *supra* note 241, at 3245.

249 *Id.*

250 *Id.* at 3248.

way on material alternatives, like plant proteins that can make production feasible, this innovation remains in its infancy.[251]

VIII. THE QUIET BET: TRADITIONAL AGRICULTURE'S HIDDEN HAND IN CULTIVATED MEAT

In scrutinizing the scalability of lab-grown meat, the shifting tides become increasingly apparent. The traditional agriculture giants, colloquially referred to as Big Agriculture (Big Ag), are facing an uncertain future. The meat production arena is set for a clash of titans. On one side lies the entrenched agriculture conglomerates, and on the other side lies the lab-grown meat companies.[252] In this battle, Big Ag has the upper hand, leveraging its overwhelming resources and considerable political clout. A prominent Big Ag association has recently lodged a comprehensive 125-page federal petition, pushing for regulatory language that reserves the terms "beef" and "meat" exclusively for traditionally sourced products, effectively barring cell-cultured alternatives from adopting such terminology.[253] The driving force behind Big Ag's maneuvers is clearly economically motivated by protecting their bottom line. Big Ag has consistently wielded vast resources to influence policymaking, intending to inhibit the rise of cell-based meat production.[254] Big Ag, through efforts to thwart its competitors, attempts to protect its crown jewel: the significant profits derived from traditional agriculture and meat production.[255]

The incumbents of meat production are armed for battle with influential entities, such as the National Cattlemen's Beef Association ("NCBA"), at the frontlines. This political heavyweight is advocating for precise terminology to distinguish lab-grown meat from conventionally harvested meat. The NCBA argues that labels such as "cultivated meat" are misleading as they suggest that the product is farm-

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251 *Id.*

252 Andrew Zaleski, *Inside the Battle Between Big Ag and Lab-Grown Meat*, NEW REPUBLIC (Apr. 21, 2023), https://newrepublic.com/article/171709/inside-battle-big-ag-lab-grown-meat.

253 *Id.*

254 *See id.*

255 *See id.*

raised, potentially swaying consumers at the point of purchase due to their perceived farm origins of the meat product.[256] Concurrently, Big Ag has been proactive in shaping consumer perceptions through strategic marketing tactics and leveraging programs, such as Beef Checkoff. [257] For the past forty years, Beef Checkoff has collected one dollar per head of cattle sold in the United States to fund its promotional ventures.[258] This is the same program, through costly research, that created and coined the term "flatiron steaks," transforming the once-overlooked chuck roast into a prized culinary offering.[259] When it comes to protecting terminology within the regulatory landscape, Big Ag's expertise is unequivocal—it has mastered the art of safeguarding terminology.

Despite the NCBA's victories through programs like Beef Checkoff, anxiety still stirs among traditional meat producers, as lab-grown meat producers adopt established beef product names. Most traditional producers fear that lab-grown beef's proposed terminology blurs the line distinguishing the two different production methods.[260] Moreover, the NCBA champions the creation of distinct food standards for lab-grown meats, pressing the need for transparent labeling that clarifies the origins of the meat.[261] The NCBA advocates for a cooperative approach with regulatory bodies and cell-based companies to coin unique product names, thereby avoiding consumer confusion.[262] Notably, the association resists any mandate for labels on conventional meats to specify origination from raised and

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256 *Id.*

257 *See About the Beef Checkoff Program*, BEEF CHECKOFF PROGRAM, https://www.beefboard.org/checkoff/about-checkoff/ (last visited Apr. 28, 2025).

258 *See id.*

259 *See* Ernie Smith, *How Meat Science (and Marketing) Gave the World the Flat Iron Steak*, ATLAS OBSCURA (Oct. 3, 2016), https://www.atlasobscura.com/articles/how-meat-science-and-marketing-gave-the-world-the-flat-iron-steak.

260 *See NCBA Fights for Definitive Labels on Lab-Grown Meat*, NAT'L CATTLEMEN'S BEEF ASS'N (Dec. 1, 2021), https://www.ncba.org/ncba-news/news-releases/news/details/28482/search.aspx.

261 *See id.*

262 *See id.*

harvested animals, maintaining that existing knowledge and perceptions are sufficient for consumer understanding.[263]

In this unfolding saga of food production and competition between incumbents and the newcomers, traditional agriculture—often cast as resistant to change through its lobbying efforts— may not be threatened as one would think. Instead, traditional agriculture is simply waiting in the wings. Behind the scenes, Big Ag is quietly charting a course toward collaboration with the lab-grown meat sector.[264] Major meat producers such as Tyson, JBS, and Cargill are not only pumping funds into research but also acquiring stakes in the rising lab-grown meat companies.[265] On the European front, JBS has strategically acquired Spanish-based BioTech Foods, while on the American front, Cargill has invested in Memphis Meats and Aleph Farms.[266] The undertakings of these key players signal interest and commitment to the lab-grown meat movement on an international level.[267]

Moreover, Tyson Foods has discreetly been laying more complex groundwork for a significant presence in the lab-grown meat market through Tyson Ventures, the company's venture investing arm.[268] The company took pioneering steps when it invested in Upside Meats with nearly half a billion dollars in the company's Series B funding round and further investment in 2021.[269] Early statements from a Tyson press release outlined its vision to bolster their legacy meat business while simultaneously venturing into alternative proteins to diversify consumer options.[270] This dual strategy could be in-

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263 *See NCBA Lays Out Principles for Regulating Fake Meat*, NAT'L CATTLEMEN'S BEEF ASS'N (Apr. 10, 2018), https://www.ncba.org/ncba-news/news-releases/news/details/25563/ncba-lays-out-principles-for-regulating-fake-meat.

264 *See The Big Names Investing in Lab-Grown Meat*, *supra* note 21.

265 *See id.*

266 *Id.*

267 *See id.*

268 *See id.*

269 *Id.*

270 *See Tyson Foods Invests in Cultured Meat with Stake in Memphis Meats*, TYSON FOODS (Jan. 29, 2018), https://www.tysonfoods.com/news/news-releases/2018/1/tyson-foods-invests-cultured-meat-stake-memphis-meats.

terpreted as a visionary effort to align with more sustainable meat production processes, or alternatively, a strategic move to construct a commanding position in the expanding market.[271] In these early days, it is unclear if the industry giant is focused on innovation or creating yet another oligopoly in the meat sector—only time will tell.

Beyond Big Ag's maneuvers, the historic confrontation between the industry's Goliaths and the smaller Davids is re-emerging in the current lab-grown meat context. Small farmers, once marginalized by Big Ag, are now facing similar sidelining from the lab-grown meat sector, hindered by exorbitant market entry costs and complex technology systems, such as bioreactors.[272] Throughout the U.S., the common sentiment among farmers about lab-grown meat is one of skepticism and concern, particularly regarding the nutritional composition of lab-grown meat.[273] One of the major apprehensions centers around the absence and impossibility of phytonutrients in lab-grown meat. Farmers emphasize that phytonutrients are beneficial to the human diet because the nutrients can "contribute to the maintenance of good health, not only through their antioxidant activity, but also as anti-inflammatory and anti-carcinogenic agents." [274] Nevertheless, farmers' concerns underscore the potential nutritional shortcomings of lab-created meat products and reinforce their skepticism.

Though shrouded in doubt, there is emerging optimism in the traditional farming community. In the Netherlands, a groundbreaking research initiative is unfolding, offering a renewed sense of promise to farmers about the future of meat production.[275] Spearheaded by researcher Ira Van Eelen, this initiative advocates for a decentralized system, where smaller-scale cultivated meat producers collaborate

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271 *See id.*

272 *See* Cookson Beecher, *Lab Meat Down on the Farm? It's Going to Happen, Say Advocates*, FOOD SAFETY NEWS (Sept. 17, 2024), https://www.foodsafetynews.com/2024/09/lab-meat-down-on-the-farm-its-going-to-happen-say-advocates/.

273 *Id.*

274 *See* Nicolas Monjotin et al., *Clinical Evidence of the Benefits of Phytonutrients in Human Healthcare*, 14 NUTRIENTS 1712, 1712 (Apr. 20, 2022).

275 *See* Francesco deAugustinis, *The Future of Lab-Grown Meat? In the Netherlands, It's Locally Grown*, SENTIENT MEDIA (Dec. 18, 2023), https://sentientmedia.org/lab-grown-meat-netherlands/.

directly with local farmers.[276] Through this revolutionary model, funded by the European Union and a consortium of private entities, the project aims to not only transform meat production methods but also harmoniously integrate avant-garde biotechnologies into traditional farming practices. [277]

The primary mission of the initiative is to reinstate farmers at the core of meat production, albeit on a cell-based method.[278] The ongoing pilot project is taking place on a 70-acre family-owned farm where bioreactors are housed in barns, further illustrating the potential for symbiotic relationship possibilities between modern science and age-old farming techniques and traditions.[279] While this project was initially met with reluctance from the local farming community, the tides have gradually begun to turn.[280] Throughout the research venture, more farmers recognize the environmental and ethical benefits of the integrated approach, including reduced nitrogen pollution and a departure from animal slaughter.[281] Ultimately, this Dutch endeavor paints an optimistic picture for farmers worldwide—not just in the Netherlands.[282] It is a signal to farmers everywhere that a future filled with technological harmony and tradition can build a more sustainable, eco-conscious, animal-friendly approach to farming.

IX. THE MEAT OF TOMORROW: CLOSING REFLECTIONS ON LAB-GROWN INNOVATIONS

The ascent of lab-grown meat is a testament to human innovation in the face of pressing global challenges, poised to redefine our relationship with food. This flourishing industry, conceived in the compulsion of environmental and ethical imperatives, offers a significant departure from traditional meat production. Lab-grown meat

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276 *Id.*

277 *See id.*

278 *See id.*

279 *See id.*

280 *See supra* note 274.

281 *See id.*

282 *See id.*

heralds a future where the appetite of humans does not necessitate a nefarious bargain with the planet's fragile ecosystem. Although this beacon of hope and promise shines bright, it simultaneously casts dark shadows, providing a cautionary warning that its very promise is ensnared by complicated challenges.

In the regulatory realm, agencies stand as the gatekeepers of public health and fair markets, confronted with the formidable task of molding enduring food safety laws to fit the contours of a completely unprecedented food product.[283] Just as the lawmakers before us responded to the urgencies of their day with the creation of their statutes, modern regulators are now called upon to forge new guidelines from scratch. These future regulations must not only reinforce the defenses of lab-grown meat's integrity and safety but also possess forward-thinking insight as we attempt to mitigate the risks that lie ahead. The FDA and USDA play a key role in this regulatory journey, having already laid the foundation for interagency collaboration that will soon become indispensable as lab-grown meat transitions from the Petri dish to grocery store shelves. The health concerns of lab-grown meat, despite the various safeguards in place in the pharmaceutical-grade environment, are not without potential for Pandora's box. The unique challenges often seen with food safety laws necessitate not only frequent safety assessments, but also a promise to adapt and refine regulatory standards as the industry and technology advance.[284] The assurance of cleaner, safer meat is a siren song that indeed beckons, yet is undoubtedly interrupted by a litany of questions that persist.

Moreover, often seen as simply a regulatory conventionalism, labeling assumes a powerful post in the lab-grown meat narrative. The naming of lab-grown meat is more than a government-controlled compliance yardstick. Rather, labeling serves as the vehicle for how the narrative of lab-grown meat is explained to a global audience—admittedly a skeptical one.[285] Labeling standards carry a hefty re-

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283 *See* GOOD FOOD INST., *supra* note 68, at 56–57.

284 *See id.*

285 *See* Flora Southey, *The Best Terminology for Cell-Based Meat? Experts Weigh In*, FOOD NAVIGATOR (Oct. 28, 2021), https://www.foodnavigator.com/Article/2021/10/27/The-best-terminology-for-cell-based-meat-Experts-weigh-in.

sponsibility, ensuring consumers are granted sound information on the products they consume as they move through the aisles of grocery stores. Both producers of lab-grown meat and agency regulators set the stage for presenting this new information in an approachable manner to the anxious public, all while remaining fair in their marketing descriptions.

Beneath the glossy exterior of cultured meat's radiant, self-proclaimed potential, we can uncover a complicated web of economic and environmental repercussions lurking beneath. The cultivation processes of lab-grown meat—while an impressive scientific feat—incurs a significant price tag due to its enormous level of energy consumption.[286] This economic demand risks undermining the utopian vision of the meat industry liberated from environmental degradation.[287] The ripple effect is further felt in traditional farming communities, already at the margins; the era of lab-grown meat poses a risk and presents a potential shift in the agricultural tapestry that has made up our agrarian life for several thousands of years.[288]

The farmers who have long been the backbone of our food supply chains find themselves grappling with progress and preserving their traditions, while recognizing that their livelihoods are now in jeopardy. The ubiquitous uncertainty compels us to consider the social and economic safeguards necessary to ensure progress and integration of the new technology. It is indeed imperative that the growing sector does not usher in a twilight for those who have fed the world for generations. However, if companies and regulatory bodies prioritize integration over profit, our society could realize an efficient new system of meat production entirely.[289]

On the other hand, Big Ag, which has long guided the food industry and gripped the supply chain, has responded with both skepticism and strategic investment as the cultured meat landscape unfolds. Its skepticism and strategy alike underline a deep-seated

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286 *See* Quinton, *supra* note 14.

287 *See id.*

288 *See* Aditi, *Are Lab-Grown Meat Alternatives the Future of Sustainable Biodiversity?*, GREEN TECHPRENEUR , https://greentechpreneur.com/are-lab-grown-meat-alternatives-the-future-of-sustainable-biodiversity/ (last visited Feb. 26, 2025).

289 *See The Big Names Investing in Lab-Grown Meat*, *supra* note 21.

trepidation and conscious observation that the grounds are shifting. The archetypical clash between the old and the new, between the entrenched and emergent, is charged with palpable tension, recognizing that the future of meat production is uncertain, along with the very definition of meat itself.

As research emerges, the environmental narrative of lab-grown meat becomes one of the most controversial facets of the incoming industry. The overwhelming number of contradictory findings leaves this area of science steeped in a constant state of contention and debate. While some studies promise that the long-term viability of lab-grown meat will soon yield a greener alternative, other studies find that improved technology must precede the advancement of such promises.[290] It is now the biotech companies and lab-grown meat producers' responsibility and duty to acknowledge that the path to the greener tomorrow is littered with ecological ironies that negate its very purpose.

In the final reckoning, as this Article concludes, cultured meat is brimming with radical potential while it precariously stands at the intersection of societal expectations and technological advancement. The regulatory and technological journey from the lab to label encapsulates a broader mission for food production that is sustainable and aligned with the consciousness of a growing population, living in a time of scarcity. Scientists, policymakers, farmers, investors, and industry giants alike, all stand at the cusp of a life-changing breakthrough that will transform the future we were once most certain would lie ahead. While legal precedent and case law are sparse and the regulatory path forward is crowded with complexity, the legal community must chart a course with judicious care, ensuring that the strides we take toward this new horizon truly serve the cause of humanity while balancing the sanctity of our planet.

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[290] *See* Risner et al., *supra* note 214, at 71.