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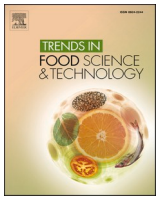

Exploring the U.S. regulatory and legislative landscapes for cell-cultivated meat and seafood

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ABSTRACT

As the global protein demand increases, cell-cultivated meat and seafood may address some key food system challenges linked to conventional agriculture and help feed a growing global population. The policy environment for these products can aid or hinder their entry and success in the market. This article reviews the federal- and state-level regulatory and legislative landscapes for cell-cultivated meat and seafood in the United States (U.S.), creating a catalogue of proposed bills and enacted laws (through October 2025) relevant to these products. We also discuss the potential implications of these legislative actions on the U.S. and global markets. The U.S. Department of Agriculture (USDA) and the U.S. Food and Drug Administration (FDA) jointly regulate the safety, production, and labeling of cell-cultivated meat, while the FDA alone regulates cell-cultivated seafood. In the absence of formal federal labeling guidance specific to cell-cultivated products, many states have established their own labeling regulations, which are likely to be preempted by federal standards, once released. Additionally, seven states to date have banned the research, production, sale, promotion, and/or distribution of cell-cultivated products, and two have prohibited the use of state funds to support them. This fragmented legislative approach may inhibit interstate and international commerce, confuse consumers, and restrict consumer access once cell-cultivated products are readily available in the U.S. market. This study can serve as a comprehensive resource for policymakers, industry leaders, researchers, and other stakeholders on the policy environment for these products and guide future research.

1. Introduction

Global demand for animal-based protein is projected to increase more than 50 % by 2050 (European Parliamentary Research Service, 2024; FAO, 2018; Searchinger et al., 2019). Concurrently, significant changes in food production, consumption, and waste are necessary to reduce the food system's environmental impact, including greenhouse gas emissions and land and freshwater use, while simultaneously expanding food production to feed a growing global population (Muhammad et al., 2025; Searchinger et al., 2019; Springmann et al.,

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2018). Some experts have recommended shifting from conventional animal-based products to alternatives, such as cell-cultivated, fermentation-derived, and plant-based protein sources, that could help meet rising protein demand within planetary boundaries (El Wali et al., 2024; Springmann et al., 2018).

Cell-cultivated meat and seafood are produced by growing animal cells in controlled facilities, eliminating the need to raise and slaughter animals directly, though they rely on inputs from conventional agriculture (Post et al., 2020). These alternative protein products may offer promising innovations to help ensure future food security. While the technology is still emerging, some early life cycle analyses have indicated the potential for cell-cultivated products to have lower environmental impact compared to conventional livestock production for indicators such as agricultural land use, air pollution, and nitrogen-related emissions; yet, there is no universal agreement on this in the absence of validated, real-life production data (El Wali et al., 2024; Post et al., 2020; Sinke et al., 2023; Tavan et al., 2025). Furthermore, the sector faces ongoing challenges associated with scale-up and costs, which may limit its success in reaching mass production in the near term, and conflicting public perceptions that may hinder product acceptance (Rosenfeld & Tomiyama, 2023).

Globally, the development of cell-cultivated food products has driven countries to evaluate whether existing food regulatory frameworks are suitable for these products and, if not, how to adapt those frameworks to regulate them. These regulations largely determine whether and how products can enter the market. Regulatory frameworks vary globally, and Singapore was the first country to approve a cell-cultivated food under its regulatory framework (Li et al., 2025).

While not yet widely available in the United States (U.S.) market, U.S.-based companies developing cell-cultivated meat and seafood products have been actively engaged in regulatory efforts for several years. In 2023, the U.S. government first approved a cell-cultivated product (chicken) for sale—second only to Singapore (Benson & Greene, 2023). Yet state-level legislative actions to restrict the labeling of cell-cultivated products pre-dated their availability in the U.S. market. Since 2018, state-level laws have been introduced to restrict the use of terms like "meat" to products from farmed or wild-caught animals, excluding their use to describe alternative protein products, including cell-cultivated products (Mo. S.B. 627). Recently, these legislative and regulatory restrictions have progressed. Some U.S. states have proposed legislation to inhibit market entry for cell-cultivated products, including through restricting research, production, sale, promotion, use of public funding, and/or distribution.

When studying the social context of cell-cultivated products to date, researchers have emphasized ethics and consumer acceptance rather than political and institutional considerations (Stephens et al., 2018). Amidst an evolving policy landscape, assessing the current regulatory and legislative environments for cell-cultivated products as an emerging food technology is essential. The U.S. hosts a significant share of companies and venture capital in the global cell-cultivated protein sector (Good Food Institute, 2024a), making the U.S. an interesting case study for analyzing cell-cultivated policy actions. Several articles have described the regulatory framework for cell-cultivated products (Post et al., 2020; Vlčko et al., 2023) and nomenclature considerations in the U.S. (Hallman et al., 2023; Malerich & Bryant, 2022; Ong et al., 2020). However, these articles have not addressed recent legislative considerations to outline the potential implications of the U.S. policy landscape on the sector's future success. Researchers have also recently described the current legislative landscape for cell-cultivated meat in the European Union context (Lanzoni et al., 2024; Monaco, 2025). Yet no peer-reviewed literature has comprehensively cataloged proposed and enacted state and federal legislation seeking to regulate whether and how cell-cultivated meat and seafood are researched, produced, marketed, sold, or distributed in the U.S. While multiple articles have mentioned the existence of state-level bans and labeling restrictions for cell-cultivated products (Fino et al., 2024; Marquez et al., 2025; Vlčko et al., 2023), none has analyzed all relevant legislation or explored the potential interactions between state- and federal-level policies.

This review addresses a gap in the literature by providing an overview of the U.S. legislative landscape for cell-cultivated meat and seafood through October 2025. In addition, this paper examines the current U.S. regulatory framework, focusing specifically on the labeling of cell-cultivated meat and seafood. We explore potential future implications of regulatory and legislative actions on interstate commerce, consumer acceptance, product transparency, and the long-term viability of cell-cultivated products domestically and globally. By providing a thorough summary of U.S. policy actions and a perspective on their implications, this work may serve as a valuable resource for policymakers, industry leaders, researchers, and other stakeholders interested in cell-cultivated meat and seafood and alternative protein products more broadly.

2. Regulatory environment for cell-cultivated meat and seafood

2.1. U.S. regulation of cell-cultivated meat and seafood

The introduction of cell-cultivated products into the U.S. market necessitated tailored oversight to ensure the safety of these products. Like all food products, regulation is crucial not only for ensuring product safety, but also for building consumer trust and transparency in the ingredients and production processes (Grieger et al., 2016). Regulation of cell-cultivated meat and seafood requires adapting existing legal frameworks for food safety and labeling to account for novel processes involving animal cell culture. Such processes have not previously been used in the food supply and are often derived from biomanufacturing practices commonly used in the pharmaceutical industry.

In the U.S., the U.S. Department of Agriculture (USDA) and the U.S. Food and Drug Administration (FDA) share oversight of the food supply. The USDA regulates most conventional meat products under the Federal Meat Inspection Act (FMIA, 21 U.S.C. §§ 601 et seq.) and poultry products under the Poultry Products Inspection Act (PPIA, 21 U.S.C. §§ 451 et seq.) to ensure that any product in interstate or foreign commerce is wholesome, not adulterated, and properly marked, labeled, and packaged. The USDA's Food Safety and Inspection Services (USDA-FSIS) inspects all facilities that process meat, and products cannot be marketed until the facility receives a grant of inspection. Additionally, the USDA-FSIS must approve the labels for all conventional meat products that contain 3 % or more raw meat or 2 % or more cooked meat before they can be marketed for interstate commerce.

The FDA regulates all food products not regulated by the USDA under the Federal Food, Drug, and Cosmetic Act (FFDCA, 21 U.S.C. §§ 341et seq.). This includes all other non-livestock or poultry food products, including fish and seafood (except for catfish). The FFDCA requires that food not be adulterated or misbranded and that the FDA pre-approves all food additives—defined as new substances that are added to food—unless they are generally recognized as safe (GRAS). Other than food additives, the FDA does not pre-approve food before it enters the market. The FDA does not pre-approve food labels, but it does provide standards of identity, regulations, and guidance on food labeling requirements (FDA, 2013).

Initially, whether regulation of cell-cultivated meat from livestock and poultry should fall under the FDA's or the USDA's purview was unclear, as its production involves processes and inputs/outputs that fall under the jurisdiction of both agencies (Benson & Greene, 2023). The Congressional Research Services' report describes the debate among stakeholders on which agency should be responsible for the oversight of cell-cultivated meat (Benson & Greene, 2023). Following these debates, in 2019, the FDA and the USDA-FSIS established a joint regulatory framework for cell-cultivated products for species covered by the FMIA and PPIA (FDA, 2019). This division of responsibilities does not apply to cell-cultivated seafood (aside from catfish), game meat, or any food products intended for animal consumption, which fall exclusively under

FDA jurisdiction. For those products, the FDA is solely responsible for all oversight from product development through harvesting, packaging, and labeling.

Under the joint regulatory framework, the FDA is charged with regulating the upstream processes, including collection, banking, growth, and differentiation of cells for cultivated livestock, poultry, and catfish products (FDA, 2019). The FDA offers pre-market consultations with companies wishing to sell cell-cultivated foods, during which companies must provide data demonstrating the product's safety for human consumption. Once evaluated and deemed safe through the FDA pre-market consultation (i.e., the company receives a "no questions" letter), the FDA oversees inspections at cell banks and other facilities that culture, differentiate, or harvest cells, which includes all components and inputs for the cell culture (FDA, 2023). Core to the FDA's responsibility is ensuring that the processes used to produce cell-cultivated foods are safe and lawful as prescribed in the FFDCA (21 U.S.C. §§ 341 et seq.).

At the point of harvest, responsibility transfers to the USDA-FSIS, which has regulatory oversight of downstream elements (i.e., harvesting, food product processing, packaging, and labeling of cultivated cells from livestock and poultry) (USDA, 2023). Any facility that cultivates livestock, poultry, or catfish and harvests or processes the product in-house is subject to USDA-FSIS inspection. Additionally, all cell-cultivated products must receive a USDA mark of inspection before being sold (FDA, 2019), verifying that the production facilities meet the FMIA or the PPIA requirements for sanitation, Hazard Analysis, and Critical Control Points (HACCP) plans, and factory design (Benson & Greene, 2023). Countries that wish to export products made from cell-cultivated livestock or poultry cells to the U.S. must also undergo inspection and approval from the USDA-FSIS. Currently, no country is eligible to export these products to the U.S. for sale for human consumption (USDA, 2023).

Similar to conventionally produced meat, poultry, and catfish, the USDA-FSIS oversees pre-approvals of labels for cell-cultivated livestock, poultry, and catfish products (USDA, 2023). The FDA ensures that labeling for cell-cultivated seafood (excluding catfish) and game meat products is not misbranded but does not require pre-market labeling approval.

As of October 2025, five cell-cultivated products—from companies UPSIDE Foods, GOOD Meat (Eat Just), Mission Barns, Wildtype, and Believer Meats—have successfully passed through the FDA premarket consultation process, having received "no questions" letters from the FDA (FDA, 2025a). Four of those products have also received their grant of inspection and label approval from the USDA (Benson & Greene, 2023; Mission Barns, 2025; Mridul, 2025). Wildtype salmon's oversight only involves the FDA's pre-market consultation process before marketing to consumers. Table 1 lists the cell-cultivated product regulatory reviews that have been completed in the U.S. as of October 2025.

Table 1
Cell-cultivated products that have completed regulatory review in the U.S. as of October 2025.

Year[a,b]	Product	Company
2022 FDA and 2023 USDA	Cell-cultivated chicken	Upside Foods
2023 FDA and USDA	Cell-cultivated chicken	GOOD Meat (Eat Just)
2025 FDA and USDA	Cell-cultivated pork fat	Mission Barns
2025 FDA (does not need USDA approval)	Cell-cultivated salmon	Wildtype
2025 FDA and USDA	Cell-cultivated chicken	Believer Meats

[a] Information on completion of the FDA review process from FDA Human Food Made with Cultured Animal Cells Inventory, 2025; (FDA, 2025a).

[b] Information on completion of the USDA review process from Benson & Greene, 2023, Mission Barns, 2025; Mridul, 2025.

Additional cell-cultivated products are under review in the U.S.

2.2. Existing labeling laws relevant to cell-cultivated meat and seafood

Labeling regulations are a critical consumer-facing part of food regulations. Labels aim to provide accurate information to consumers to help them make informed decisions on food choices. For companies, it is a direct way to communicate with consumers (USDA-FSIS, 2007). Governments use labeling regulations to ensure industry compliance and consumer transparency on the products sold in a specific country or regulatory jurisdiction (Grieger et al., 2016).

Per regulations, U.S. food labels must include a standard of identity—a legally defined definition and composition specified for some foods—when one exists (21 C.F.R. Part 101; FDA, 2025b). Several meat products have a defined standard of identity or composition that the USDA-FSIS enforces (9 C.F.R. Part 319). For example, in the case of ham, the product's minimum meat concentration is defined in the law. If a standard of identity or composition is not available, the products shall be identified by a common or usual name (21 U.S.C. § 343(i)(1)). The common or usual name "shall accurately identify or describe, in as simple and direct terms as possible, the basic nature of the food or its characterizing properties or ingredients," (e.g., "potato chips" or "beef round"). The name must be used on all products of the same nature, and it should not be similar to the name of any other food (21 C.F.R. § 102.5). If no common or usual name exists, the label must include a descriptive term, defined as a term that the public commonly uses for such food (e.g., "chicken and vegetable in dough") (USDA-FSIS, 2007).

All three federal statutes that regulate the U.S. food supply – the FFDCA, FMIA, and PPIA – include provisions that limit states or localities from establishing laws or regulations that conflict with or are additional to federal oversight. Referred to as "federal preemption," these provisions are derived from the Supremacy Clause of the Constitution (21 U.S.C. § 343-1; 21 U.S.C. § 467e; 21 U.S.C. § 678). Under federal preemption, if the FDA or USDA establishes regulations or standards for the safety, packaging, or labeling of cell-cultivated products, states cannot impose any regulations or requirements that differ from the federal requirements (21 U.S.C. § 678; 21 U.S.C. § 467e). Since the USDA-FSIS approves every label for products regulated under the FMIA and PPIA before they enter commerce, the label itself can be considered a federal requirement.

2.3. Lack of standardization in cell-cultivated product labeling

To date, the U.S. has not established federal labeling requirements specific to cell-cultivated meat and seafood. To develop federal regulations, the USDA issued an Advanced Notice of Proposed Rulemaking in September 2021 and sought public comments on how cell-cultivated meat and poultry products should be labeled (USDA, 2021). Many cell-cultivated companies, the conventional agriculture industry and trade groups, consumer groups, and other stakeholders provided comments to the USDA outlining diverse perspectives on how these products should be labeled (Poinski, 2022). In total, 1207 comments were submitted (Failla et al., 2023). Although the proposed labeling regulations were expected to be released in 2024, at the time of writing, the USDA has not announced any regulations. The FDA also requested labeling comments regarding cell-cultivated seafood in October 2020 (FDA, 2020), but has not published any formal regulations for cell-cultivated seafood to date.

Labeling approvals for cell-cultivated meat products are currently conducted on a case-by-case basis by the USDA-FSIS (USDA, 2023). Similar to the conventional meat industry, cell-cultivated meat companies are required to submit labels to the USDA-FSIS for preapproval to ensure that the labels are truthful and not misleading before entering the market. Once the label is approved, the company is required by law to use that label and cannot change the language or add qualifying information.

At the time of writing, UPSIDE Foods and GOOD Meat have received approval from USDA-FSIS to label their products as "cell-cultivated chicken" (Benson & Greene, 2023). Likewise, Mission Barns received approval to label their products containing cell-cultivated pork fat ingredient as "cell-cultivated" (Mission Barns, 2025). While not published by the agency, a USDA-FSIS officer has stated that some of the basic labeling requirements for the cell-cultivated products approved so far include using the terms "cell-cultured" or "cell-cultivated," which must be the same size, color, and font style as the rest of the product name (Crawford, 2024).

When it comes to cell-cultivated seafood, what terms are federally acceptable are less clear, as the FDA does not pre-approve labels. In the "no questions" letter for Wildtype, the FDA stated that "the use of the term 'cultured salmon cell material' in this letter is not our recommendation of that term as an appropriate common or usual name for declaring the substance in accordance with FDA's labeling requirements" (FDA, 2025c). Rather, "cultured salmon cell material" was solely the term that the FDA used to refer to Wildtype's product during the consultation process. Further, the letter notes that the FDA Office of Nutrition and Food Labeling, which oversees labeling, was not consulted during the safety evaluation process. Currently, Wildtype uses "cultivated" in their external communications (e.g., Wildtype, 2025). Any future federal rulemaking may change previously approved labeling for cell-cultivated products (Pugliese & Crotty, 2024).

2.4. Proposed nomenclature for cell-cultivated products

A variety of terms have been used in literature, legal documents, and popular media to describe cell-cultivated meat and seafood products. Early on, the industry backed the term "clean meat," which studies found was preferred by participants in terms of willingness to purchase products (Hallman & Hallman, 2020; Malerich & Bryant, 2022). "Clean meat" then received pushback from the livestock industry, which, along with other stakeholders, used phrases such as "lab-grown," "fake meat," "synthetic," and "artificial" to describe cellular agriculture products. More recently, proponents of cell-cultivated products have adopted the term "cultivated," particularly after a survey of industry leaders by the Good Food Institute (GFI) found that 75 % of cell-cultivated companies prefer that term (Benson & Greene, 2023; Friedrich, 2021). "Cultivated" was also the most supported term by organizations in the submissions to the USDA-FSIS request for information (Malerich & Bryant, 2022), while "cultured" was the most prevalent term mentioned when considering all submissions (including those from individuals) (Failla et al., 2023).

Many cell-cultivated companies and supporters oppose the use of terms like "lab-grown" and "artificial" for multiple reasons (Good Food Institute, 2025a; Hallman et al., 2023). First and foremost, these terms are inaccurate because these products are formulated with animal and plant-derived ingredients that are not synthetic. Additionally, when produced at scale, a cell-cultivated production facility is more akin to a brewery than a laboratory. Furthermore, these terms carry a negative connotation that could adversely affect consumer perceptions and harm the industry (Malerich & Bryant, 2022).

Some conventional agriculture stakeholders have opposed the use of the term "meat" altogether, and it has been unclear whether the USDA definition of meat ("part of the muscle of any cattle, sheep, swine, or goat which is skeletal") or meat product ("any product … made wholly or in part from any meat or other portion of the carcass") can be interpreted to a product made from animal cells (USDA, 2018; Ong et al., 2020). According to some stakeholders, the term "meat" should be restricted to conventional animal meat for semantic and commercial reasons, in addition to biological factors (Chriki et al., 2022). The more recent incidences—including USDA-FSIS approving the use of the term "cell-cultivated chicken," and the FDA proposing in a draft guidance that terms like "bacon," "jerky," or "fish" can be used for plant-based products as long as the ingredients and non-meat origin are indicated in the statement of identity (FDA, 2025d)—suggest that the use of "meat" with qualifying additions may be federally acceptable.

Considering the requirements for a common or usual name, the term must sufficiently differentiate the product from conventional meat while informing consumers of its origins and providing sufficient information on its allergenicity (Hallman et al., 2023). Research indicates that the prefix "cell" increases consumers' understanding of the product, and that "cell-based," "cell-cultivated," and "cell-cultured" best meet the regulatory requirements around communicating safety and allergenicity while appealing to consumers (Hallman et al., 2023; Malerich & Bryant, 2022). It should be noted that such terminology and framing may be culturally contingent, as the popularity of these terms varies between different geographical areas (Song et al., 2024).

Most cell-cultivated products approved for sale and under development globally today are formulated using both animal cells and plant-based ingredients. Plant-based ingredients, rather than animal cells, are the primary component in many of these products due to current technological and cost constraints in scale-up production of animal cells. To date, pure cell-cultivated products remain uncommercialized (Bamezai & Chapman, 2025). For example, GOOD Meat's cell-cultivated chicken and Vow's foie gras made with cell-cultivated quail, both available on the market in Singapore (and Vow also elsewhere), contain 3% chicken cells and 51% cultured quail mixed with plant-based ingredients (Bamezai & Chapman, 2025). These factors are relevant when considering nomenclature, as any term or definition for cell-cultivated products should reflect the possibility that these products may not be entirely derived from animal cells. One labeling consideration is whether the percentage of the cultured cells should be included and required. The proportion of animal cells in the products may increase in the future as the costs of the cell-culture media and processes decrease with technological advancements.

3. Legislative actions involving cell-cultivated meat and seafood

Despite existing USDA and FDA oversight, over the last few years, congressional and state legislators have proposed—and in many cases, passed—legislation aimed to regulate cell-cultivated products at the federal or state level. No federal or state legislators have proposed or adopted any legislation that would require state-level review and/or approval of a product separate from or in addition to the current safety determinations conducted by the USDA and FDA. Instead, in the absence of published federal labeling guidelines specific to cell-cultivated products, much of the state legislation has focused on how these products are labeled. Some legislators have also sought more restrictive legislation to ban cell-cultivated research, production, sale, promotion, distribution, and/or public funding. Assessing federal and state proposed bills and enacted laws relevant to cell-cultivated meat and seafood can provide insight into the policy landscape that cell-cultivated products must navigate when entering the U.S. market.

To identify relevant legislative actions, a desk review of state and federal websites, media articles, and related grey literature documents was conducted. Iterative Google searches were conducted to identify relevant legislation using a series of search phrases, such as ("cultivated meat" OR "cultivated protein") AND (ban* OR law OR bill) AND ("United States" OR U.S. OR US). Both forward and reverse snowballing were also used to identify relevant legislation. Additionally, we conducted internet searches using each state name and the words "ban" and "label" to ensure that all relevant state legislation was identified. Legislation was cross-referenced on the relevant state legislative website and LegiScan. In the following sections, both bills and laws are presented using the respective bill number. In contrast, the full legal references, including all modifications and additions to existing laws, are provided in Supplementary Table 1.

3.1. Labeling legislation

3.1.1. Federal-level legislation

At the federal legislative level, the Fair Labels Act of 2024 was introduced in both the House (H.R. 7130) and Senate (S. 3693) to require that cell-cultivated meat products be labeled as "cell-cultured" or "lab-grown," with the terms listed immediately next to the name of the food item and of equal size and prominence. The Act would have also updated the FMIA definition of "meat food product" and the PPIA definition of "poultry food product" to include "cell-cultured meat product" and "cell-cultured poultry product," providing a formal definition for each (S. 3693; H.R. 7130). Some conventional agriculture interest groups supported the bill for ending "deceptive labeling practices on fake meat products" (National Cattlemen's Beef Association, 2024), while cell-cultivated product advocates called the proposal "unnecessary, burdensome, and unlikely to withstand constitutional scrutiny" (Good, 2024). The Act did not pass the House or the Senate before the end of the 118th Congress (2023-2024), so the corresponding bills expired at the end of the session. No federal-level legislative actions have been taken against cell-cultivated seafood, as the Fair Labels Act only covered cell-cultivated meat (including poultry). As of October 2025, neither the House nor the Senate for the 119th Congress (2025–2026) had proposed bills to specify labeling requirements for cell-cultivated products.

3.1.2. State-level legislation

State-level labeling restrictions relevant to cell-cultivated products date back to 2018 when Missouri became the first state to prohibit the use of the word "meat" unless the food was "from harvested production livestock or poultry," restricting its use on cell-cultivated, fermentation-derived, and plant- and insect-based protein products (Mo. S.B. 627). Proposed and enacted cell-cultivated labeling legislation has since fallen into two main categories: 1) those that ban the use of meat and/or meat-related terms on cell-cultivated products, and 2) those that require the use of "qualifying terms" alongside meat-related terms on cell-cultivated products. Many of the proposed bills and enacted labeling laws address alternative protein products more broadly, including cell-cultivated, plant-based, and fermentation-derived products.

Enacted laws from seven states (Alabama, Arkansas, Kentucky, Louisiana, Mississippi, Montana, and South Carolina) restrict the use of meat or meat-related terms, while proposed bills or enacted laws from 18 states require that labels use qualifying terms or otherwise depict that products are made from cultivated cells (Table 2; Fig. 1). Many other states have previously proposed similar bills that failed (Good Food Institute, 2024a). Oklahoma and South Carolina both initially passed laws to restrict companies from representing cell-cultivated products as meat or meat products (Okla. H.B. 3806, 2020; S.C.H. 4245, 2020). They later passed laws that outlined qualifying language requirements for cell-cultivated product labels (Okla. H.B. 1126, 2025; S.C. S. 103, 2025).

Most states with labeling laws requiring the use of qualifying terms or phrases include "cell-cultivated" in their list of approved terms, which aligns with terminology the USDA has allowed for use on the labels of approved cell-cultivated products to date. These lists often include other qualifying terms, such as "fake," "lab-grown," and "imitation," that do not align with the USDA's case-by-case approvals to date. In addition to the qualifying terms stated explicitly in the legislation (as outlined in Table 2), many states allow for the use of a comparable word or phrase beyond those listed in the definition of "qualifying term" in the legislation itself, pending state approval. However, no guidance is provided on how the state determines if a term or phrase is deemed "comparable."

If a labeling law includes USDA's approved qualifying term in its list of potential terms and does not add additional labeling restrictions (e.g., mandating font size inconsistent with federal standards), these state laws are unlikely to be subject to federal preemption. Yet labeling laws in Georgia, Indiana, Kansas, Missouri, and North Dakota require the use of qualifying terms or phrases that do not align with USDA labeling

Table 2
Proposed and enacted U.S. state-level labeling regulations for cell-cultivated meat and seafood as of October 2025.[a]

State	Legislative Reference	Year Proposed or Enacted	Cell-Cultivated Product Labeling Regulations
Enacted Laws			
Alabama	H.B. 518	2019	Prohibits labeling as meat or meat product
Arkansas	H.B. 1407 (Act 501)	2019	Prohibits representation as meat or meat product
Colorado	H.B. 25-1203	2025	Requires labeling with a qualifying term, such as cell-cultivated, cell-cultured, grown in a lab, imitation, lab-created, lab-grown, meat-free, or meatless, close to a meat term
Georgia	S.B. 211	2020	Requires labeling front of package with the terms lab-grown, lab-created, or grown in a lab
Indiana	H.B. 1425[b]	2025	Requires package to include the phrase "this is an imitation meat product"
Iowa	S.F. 2391[b]	2024	Requires labeling front of package with qualifying term such as cell-cultivated, cell-cultured, fake, grown in a lab, imitation, lab-grown, lab-created, meat free, or meatless
Kansas	S.B. 261	2022	Requires labeling with a disclaimer such as "this product does not contain meat," meatless, or meat-free, in a prominent font size near a meat term
Kentucky	H.B. 311	2019	Prohibits representation as meat or meat product
Louisiana	S.B. 152, 2019	2020	Prohibits representation as meat or meat product
Mississippi	S.B. 2922	2019	Prohibits labeling as meat or meat product
Missouri	S.B. 627	2018	Prohibits representation as meat or meat product; requires labeling qualifier, such as lab-grown or lab-created, immediately before or after product name and package label that "grown in a lab"
Montana	H.B. 327	2019	Must be labeled to indicate that it is derived from cell-cultivated cells, tissues, blood, or components
North Dakota	H.B. 1400	2019	Must be labeled as "cell cultured protein food product"; cannot be packaged in same or "deceptively similar" packaging as a meat food product
Oklahoma	H.B. 3806	2020	Prohibits representation as meat or meat product
	H.B. 1126	2025	Must be labeled with qualifying term, such as cell-cultivated, cell-cultured, fake, grown in a lab, imitation, lab-created, lab-grown, meat-free, or meatless, in close proximity to a meat term
South Carolina	H. 4245, 2020	2019	Prohibits labeling or representation as meat or 'clean meat'
	S.B. 103	2025	Front of package must include a "conspicuous label that indicates that the artificial or cell-cultivated food product is not beef, poultry, fish, crustacean, or any other animal protein that the artificial or cell-cultivated food product may resemble."
South Dakota	H.B. 1022	2025	Must be labeled with cell-cultured or lab-grown in the same size and

(continued on next page)

Table 2 (*continued*)

State	Legislative Reference	Year Proposed or Enacted	Cell-Cultivated Product Labeling Regulations
			prominence next to the product name
Tennessee	H.B. 804	2025	Prohibits labeling as a meat or meat product; requires cell-cultivated manufacturers to obtain a permit to sell products in the state
Texas	S.B. 664	2023	Must be labeled with cell-cultured, lab-grown, or similar qualifying term in equal or larger size near the product name
Utah	H.B. 138	2025	Must be labeled with a term or phrase that "is reasonably certain to notify a consumer that the food contains a cultivated meat product."
West Virginia	H.B. 5349	2024	Must be labeled with cell-cultured, lab-grown, or similar qualifying term before or after the product name
Wyoming	S.F. 68	2020	Must be labeled as "containing cell cultured product"
Proposed Bills			
Michigan	H.B. 4076	2025	Must be labeled with cell-cultured, lab grown, cultivated, cell-cultivated or a similar term or disclaimer
North Carolina	H.B. 134; H. B. 135[b]	2025	Must be labeled with qualifying term, such as cell-cultured, fake, grown in a lab, or lab-grown, in size 20-point font or the same size as the surrounding text, whichever is larger, near the meat term used
Ohio	H.B. 10[b]	2025	Must be labeled with qualifying term, such as cell-cultivated, cell-cultured, fake, grown in a lab, imitation, lab-created, lab-grown, meat free, or meatless, near the meat term used

[a] Legislative actions that did not pass through both chambers before the end of the respective legislative session are not included. Content is organized alphabetically by state name.

[b] These bills also include restrictions on commercial activities and/or government funding for cell-cultivated products that are described in Section 3.2 and Table 3.

approvals to date and could prompt preemption. Likewise, state-level labeling laws that prohibit cell-cultivated products from being represented or labeled as meat or meat products conflict with USDA's labeling approvals. The USDA has approved the use of the phrase "cell-cultivated chicken" on labels of two different cell-cultivated companies, indicating that meat terminology can be used for cell-cultivated products.

3.1.3. *Challenges against labeling laws relevant to cell-cultivated products*

Once passed, multiple state labeling restrictions faced legal challenges, primarily from plant-based companies and organizations such as GFI, the American Civil Liberties Union (ACLU), and the Plant Based Foods Association, which questioned their legality. In 2018, as Missouri's meat labeling law on plant-based and cell-cultivated products went into effect (Mo. S.B. 627), Turtle Island Foods (the parent company of the plant-based product Tofurky) and GFI filed a lawsuit against the state, arguing that the law violated the First Amendment right to commercial speech. The case bounced around the court system for multiple years before being closed, with the ruling in favor of the state (Penn State Center for Agricultural and Shale Law). However, in response to the lawsuit, the Missouri Department of Agriculture provided additional clarifying guidance stating that plant-based and cell-cultivated products would not be considered as misrepresenting meat if a qualifying term or disclosure was included on the packaging (see Table 2) (Missouri Department of Agriculture, 2018).

Following the Missouri lawsuit, similar lawsuits were filed against Arkansas, Louisiana, Mississippi, Oklahoma, and Texas (Penn State Center for Agricultural and Shale Law; Tao & Razick, 2023). Arkansas and Louisiana's labeling laws were ultimately deemed unconstitutional, although Louisiana's case was overturned on appeal (Good Food Institute, 2022; Penn State Center for Agricultural and Shale Law). While the legal challenges against states' labeling laws have focused on labeling for plant-based proteins, these cases are also relevant to cell-cultivated meat and seafood companies whose products must comply with these laws once available in the U.S. market.

3.2. *Legislation to ban commercial activities and government funding for activities related to cell-cultivated products*

In recent years, cell-cultivated products have faced additional legislative challenges with state and federal ban attempts. These efforts can be delineated into two main tiers: (1) those that aim to ban the use of federal or state government funding to support cell-cultivated research or procurement, and (2) those that aim to ban the manufacture, sale, and/or distribution of cell-cultivated products.

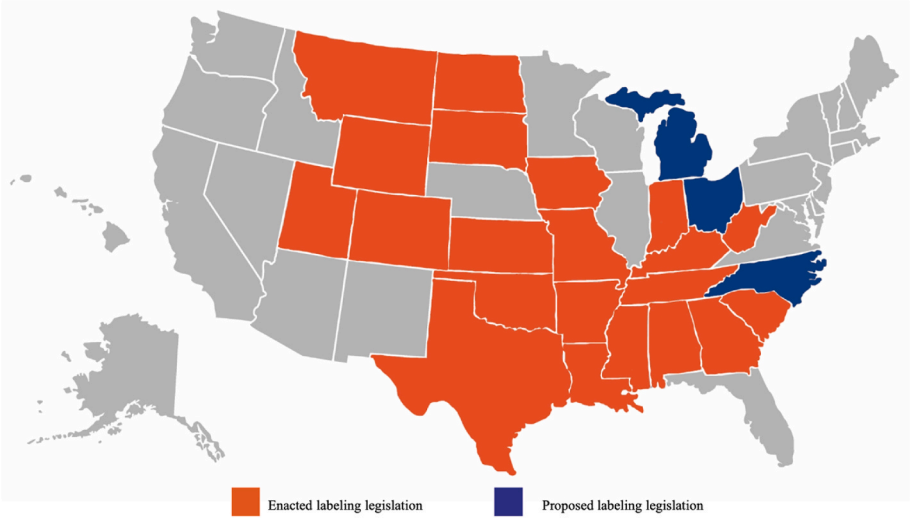

Fig. 1. U.S. states with proposed or enacted labeling legislation relevant to cell-cultivated meat and seafood products as of October 2025.

3.2.1. Attempted federal bans

At the federal level, in 2019, a Nebraska Senator introduced the Real Marketing Edible Artificials Truthfully Act, or the REAL Meat Act, with a companion bill introduced in the House of Representatives (H.R. 4881). This Act aimed to require the term "imitation" to be used on plant-based meat alternatives but did not gain initial traction in 2019 or on re-introduction in 2023 (S. 3281). The REAL Meat Act was reintroduced in updated form to the House in 2024 (H.R. 8757) and called for restricting all federal funding for cell-cultivated meat research, production, advertising, and promotion. It also proposed restricting the use of cell-cultivated meat in USDA nutrition assistance programs, including the Supplemental Nutrition Assistance Program (SNAP). Likewise, the School Lunch Integrity Act of 2024 was introduced in the Senate to prohibit the use of cell-cultivated meat within the National School Lunch Program and the School Breakfast Program (S. 3674). Neither bill moved past referral to subcommittee before the end of the 2023–2024 legislative session and therefore expired at the end of the 118th Congress. In 2023, legislators also put forth legislation to restrict research funding for cell-cultivated products that did not progress past the House (Benson & Greene, 2023; H.R. 4368).

3.2.2. State-level attempted and enacted bans

In 2024, Florida became the first U.S. state to ban the manufacture, sale, and distribution of cell-cultivated food products (Fla. S.B. 1084, Ch. No 2024-137) (Table 3). Shortly thereafter, Alabama enacted a similar law banning the "manufacture for sale," holding or offering for sale, sale, and distribution of cell-cultivated food products (Ala. S.B. 23, Act. No 2024-252). These bans went into effect on July 1, 2024, and October 1, 2024. Neither ban explicitly extended to research on cell-cultivated products. However, the distinction between Florida's ban on cell-cultivated "manufacture" may have different implications than Alabama's ban on "manufacture for sale," as the latter is more limited in scope. Banning all cell-cultivated manufacturing, as described in Florida's law, could make it illegal for companies to manufacture products for research and development purposes as well.

Arizona (Ariz. H.B. 2121), Illinois (Ill. H.B. 5872), Kentucky (Ky. H. B. 597), Michigan (Mich. H.B. 5879), New York (N.Y. A.B. 10431), and Pennsylvania (Pa. H.B. 2441) proposed bills in 2024 aimed at prohibiting cell-cultivated food product manufacture or "manufacture for sale, " sale, and holding or offering for sale that died at the end of their respective legislative sessions. Illinois, Kentucky, and New York's bills also aimed to ban the distribution of cell-cultivated food products. The bills from Tennessee (Tenn. H.B. 2860, 2024; Tenn. S.B. 2870, 2024) aimed to ban cell-cultivated food product imports meant for distribution or sale (in addition to banning distribution or sale more generally). Iowa (Iowa H.F. 2376) also proposed legislation to ban cell-cultivated manufacturing for sale in 2024, which died in committee at the end of the legislative session. Similarly, in 2023, Texas proposed a bill to ban the production, sale, or distribution of "lab-grown meat" that died in chamber (Tex. H.B. 158).

In 2025, Mississippi became the third state to ban the manufacture, sale, or distribution of cell-cultivated food products (Miss. H.B. 1006), followed by Montana (Mo. H.B. 401) and Nebraska (Neb. L.B. 246 [also restricts cell-cultivated product imports]). Also in 2025, Indiana and Texas enacted two-year bans (Ind. H.B. 1425; Tex. S.B. 261). Indiana's law temporarily bans the manufacture of cell-cultivated products, and both states temporarily ban their sale or offering for sale. Indiana and Texas's bans also outline advertising and labeling requirements to avoid misbranding cell-cultivated products as meat products that extend beyond the two-year moratoriums (Ind. H.B. 1425; Tex. S.B. 261).

As of October 2025, legislators in Colorado (Colo. H.B. 25-1064), Georgia (Ga. H.B. 201), Kentucky (Ky. H.B. 374), Maine (Me. L.D. 1257), South Dakota (S.D. H.B. 1109), Tennessee (Tenn. S.B. 0568), West Virginia (W. Va. S.B. 751), and Wyoming (Wyo. H.B. 0168) had proposed

Table 3
Proposed and enacted U.S. state-level bans on cell-cultivated meat and seafood as of October 2025.[a]

State	Legislative Reference	Year Proposed or Enacted	Cell-Cultivated Actions Prohibited
Enacted Legislation			
Alabama	S.B. 23	2024	Bans "cultivated food product" production, sale, holding or offering for sale, and distribution
Florida	S.B. 1084	2024	Bans "cultivated meat" manufacture for sale, sale, holding or offering for sale, or distribution
Indiana	H.B. 1425 (Public Law 229)	2025 (through June 30, 2027)	Temporarily bans "cultivated meat product" manufacture, sale, or offering for sale for two years; prohibits the misbranding of cell-cultivated products as meat products
Iowa	S.F. 2391	2024	Restricts public schools, community colleges, and public universities from purchasing "cultivated-protein food products"; requires that, if the USDA approves "cultivated-protein food products" for use in federal nutrition programs, the state must submit a request to USDA for a waiver to exclude cultivated-protein food products from nutrition programs (i.e., SNAP and WIC) in the state
Mississippi	H.B. 1006	2025	Bans "cultivated food product" manufacture, sale, holding or offering for sale, or distribution
Montana	H.B. 401	2025	Bans "cell-cultured edible product" manufacturing for sale, sale, holding or offering for sale, or distribution
Nebraska	Exec. Order No. 24-09	2024	Prohibits state agencies from procuring "lab-grown meat" and awardees of state-awarded contracts from discriminating against "natural-meat producers in favor of laboratory or cultivated-meat producers"
	L.B. 246	2025	Bans "cultivated-protein food product" manufacture, production, import, distribution, promotion, displaying or offering for sale, or sale
South Dakota	H.B. 1118	2025	Bans the award or use of state funding for "cell-cultured protein" research, production, promotion, sale, or distribution
Texas	S.B. 261	2025 (through September 1, 2027)	Temporarily bans "cell-cultured protein" offering for sale or sale
Proposed Bills			
Illinois	H.B. 15	2025	Bans "cultivated meat" sale, holding or offering for sale, or distribution
Michigan	H.B. 4083	2025	Bans "cultivated meat" manufacture for sale or offer or expose for sale
New Jersey	A. 4747	2024[b]	Bans "cell-based food" sale or distribution and the possession of these products with the aim to sell or distribute them
North Carolina	H.B. 135	2025	Prohibits public schools, universities, and community colleges from purchasing "cell-cultured products"
Ohio	H.B. 10	2025	Requires boards of education, the Department of Education, and state institutions of higher education to develop policies that ban the purchase of "cultivated-protein food product"; requires the state submit a waiver to prohibit the purchase of cell-cultivated products for the SNAP and WIC programs if approved by USDA

[a] Legislative actions that did not pass through both chambers before the end of the respective legislative session are not included. Content is organized alphabetically by state name.

[b] New Jersey has a biennium session from 2024 to 2025 that runs through December 31, 2025, so this bill may be considered before the end of the session (MultiState, 2025; Rogers, 2024).

bills in 2025 aimed at prohibiting cell-cultivated sale or offering for sale (and in some instances, trade/exchange) and distribution that failed to pass both chambers before the end of the legislative session. Likewise, Oklahoma (Okla. S.B. 22) proposed a bill that would restrict cell-cultivated "manufacture for sale," but it died in committee. West Virginia's bill (W. Va. S.B. 751) also restricted cell-cultivated "manufacture for sale," while Colorado (Colo. H.B. 25-1064) and Kentucky (Ky. H.B. 374) proposed banning cell-cultivated manufacturing altogether. While Tennessee and Maine's bills did not mention manufacturing, Tennessee aimed to ban the sale or distribution of cell-cultivated imports, and Maine proposed restricting the transport of cell-cultivated products within the state (Tenn. S.B. 0568; Me. L.D. 1257). Bills are under consideration in Illinois (Ill. H.B. 15), Michigan (Mich. H.B. 4083), and New Jersey (N.J. A. 4747) that aim to ban the "manufacture for sale" or "offer for sale," sale, and/or distribution of cell-cultivated products (Table 3).

Six states (Alabama, Indiana, Mississippi, Montana, South Dakota, and Texas) have passed both cell-cultivated labeling restrictions and bans (Fig. 1 and Fig. 2). While most of these states' labeling restrictions pre-dated their ban legislation by multiple years, Indiana and South Dakota proposed and passed both forms of legislation in 2025. Multiple states that proposed bans in 2025, including Illinois, Kentucky, Michigan, and Texas, had previously proposed similar legislation that died.

In addition to outright bans, states have proposed and passed legislation to restrict certain state or federal funding sources from supporting cell-cultivated products (Table 3). In 2024, Iowa passed legislation that prevents state education providers, including public schools and community colleges, from purchasing cell-cultivated meat and seafood products (Iowa S.F. 2391). In 2025, some North Carolina House legislators similarly proposed legislation to prohibit "community colleges, public universities, and public schools from purchasing misbranded products and cell-cultured products" that, as of October 2025, was under consideration in a House subcommittee (N.C. H.B. 135).

Iowa's enacted law also requires that, if the USDA approves the purchase of cell-cultivated protein products through federal nutrition programs, the state's Department of Health and Human Services must submit a waiver request to the USDA to exclude these foods from nutrition program purchase in the state (Iowa S.F. 2391). No formal USDA policy or regulation exists that permits or bans cell-cultivated meat or seafood products in federal nutrition programs. However, in 2024, Iowa submitted a waiver request to the USDA to prohibit the use of SNAP benefits for the purchase of cell-cultivated meat and egg substitutes. The USDA rejected this request as it did not meet any of the acceptable waiver criteria to warrant program exclusion (USDA, 2024). In early 2025, Oregon and Ohio proposed similar bills that aimed to restrict public schools, community colleges, and universities from procuring cell-cultivated protein products and required submission of a USDA waiver to prevent their eligibility under federal nutrition programs (Or. H.B. 2691; Ohio H.B. 10). Oregon's bill failed to pass through both chambers before the end of the state's 2025 legislative session while, at the time of writing, Ohio's bill remained with a House subcommittee for consideration.

Multiple states have sought legislation to impose broader restrictions on all state funding for cell-cultivated products. In 2024, Nebraska's governor signed an executive order (EO) to prohibit state agencies and state-awarded contracts from purchasing cell-cultivated protein products (Neb. Exec. Order No. 24-09). Likewise, in early 2025, South Dakota passed a bill to restrict state funding from being "awarded or used, directly or indirectly, for research, production, promotion, or the sale or distribution of cell-cultured protein" (S.D. H.B. 1118). Nebraska's ban was unique in that, as an EO, it did not require state legislative approval. In the justification for the EO, Nebraska's governor reiterated support for the state's conventional agriculture industry. He cited the potential for consumer confusion in the absence of labeling requirements for cell-cultivated products. The EO stated that "current research suggests that lab-grown meat's environmental impact is significantly higher than naturally produced meat," although no research was cited to support this claim (Neb. Exec. Order No. 24-09). At the governor's request, legislators subsequently introduced legislation to ban the manufacture, promotion, sale, or distribution of cell-cultivated products, which has since passed (Neb. L.B. 246).

3.2.3. *Legal challenges against state bans*

Following the first cell-cultivated ban in Florida, in August 2024, UPSIDE Foods, Inc. filed a lawsuit against the state of Florida challenging the ban (*UPSIDE Foods Inc. v Simpson et al.*, 2024). The lawsuit argued that the ban was unconstitutional, citing two constitutional provisions: 1) the Commerce Clause, which grants Congress the power to regulate interstate commerce and prohibits states from restricting it (U.S. Const. art. I, § 8, cl. 3), and 2) the Supremacy Clause (U.S. Const. art. VI, § 2). Additionally, the lawsuit indicated that by banning the sale of cultivated chicken products because they are produced from cultivated cells, Florida was imposing an "ingredient requirement" beyond the requirements set for chicken in the PPIA (*UPSIDE Foods Inc. v Simpson et*

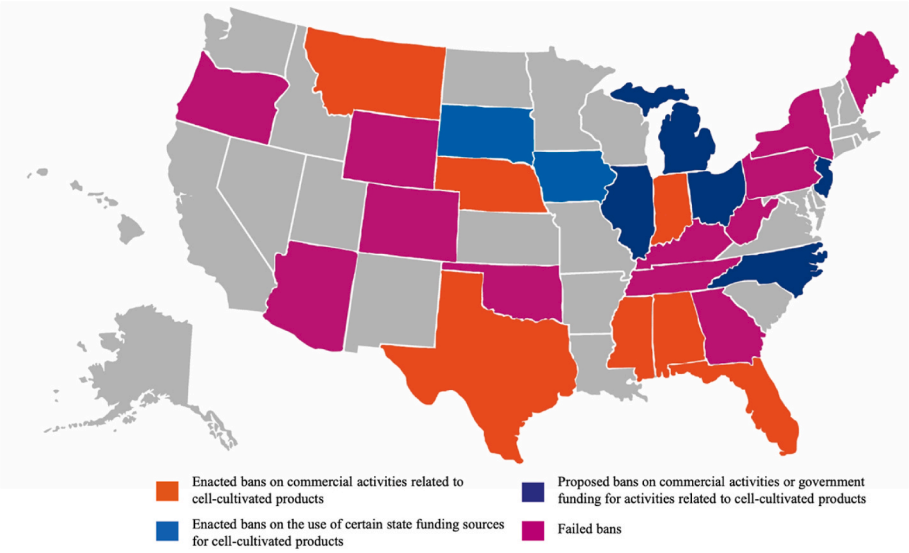

Fig. 2. U.S. states with proposed, enacted, and failed legislation aimed to ban cell-cultivated meat and seafood production, distribution, sale, and/or research as of October 2025.

al., 2024). This action is restricted under the PPIA (21 U.S.C. § 467e).

The plaintiffs (Simpson et al.) argued that Florida's cell-cultivated ban restricts out-of-state companies from fairly competing in the state's market, limiting the flow of goods between states and giving an advantage to Florida farmers and producers. It also argued that the USDA and FDA's approval of cell-cultivated chicken in the U.S. preempts states' capacities to ban the sale of these products at the state level (*UPSIDE Foods Inc. v Simpson et al.*, 2024). In April 2025, a judge dismissed the portion of the lawsuit related to preemption (the Supremacy Clause) but allowed the lawsuit to move forward on the charges of giving in-state producers an unconstitutional advantage over those from other states (Associated Press, 2025). Similarly, in September 2025, UPSIDE Foods and Wildtype filed a similar suit against the state of Texas for their cell-cultivated ban (Tex. S.B. 261), which also cited violation of the Commerce Clause and the Supremacy Clause (*Wild Type Inc. & UPSIDE Foods Inc. v Shuford*, 2025). As of October 2025, both lawsuits are ongoing, and the final decisions could set crucial precedent for the legality of other state ban legislation.

3.3. Nomenclature and definitions in state-level cell-cultivated legislation

States have used various terms and definitions to identify the universe of products covered by the provisions in the legislation. Terms used in proposed and enacted labeling and ban legislation have included "cultivated food product," "cultivated meat," "cultivated meat product," "cultivated-protein food product," "cell-cultivated food product," "cell-cultivated meat," "cell-cultured food product," "cell-cultured edible product," "cell-cultured meat," "cell-cultured product," and "cell-cultured protein" (Table 3). Definitions for these terms have varied by state, but encompass cells, tissue, or other components from "animals" or "agricultural food animals," covering both cell-cultivated meat and seafood. Definitions sometimes also included a short description of the cell-culture process. The most frequently used term was "cultivated protein-food product," with the same definition used in enacted laws from Iowa, Oklahoma, and Nebraska and a proposed bill from Ohio (Supplementary Table 2).

Many state labeling laws that restrict the use of meat or meat product terminology do not provide explicit terminology or definitions for cell-cultivated products. However, some states provided descriptions of these products when outlining what did not meet the definition of a meat or meat product. For instance, Alabama, Kentucky, and Mississippi's labeling laws share common language that "a food product that contains cultured animal tissue produced from animal cell cultures outside of the organism from which it is derived" is not a meat or meat product.

4. Cell-cultivated regulation, labeling, and legislation globally

While this article primarily focuses on the U.S. as a case study, the regulatory and legislative landscapes for cell-cultivated products around the world are evolving as these products enter the global market for the first time. Regulatory approvals for cell-cultivated products for human consumption in other countries, as of October 2025, are listed in Table 4. Additional cell-cultivated products are under regulatory review in various countries on many continents (Good Food Institute, 2025b).

Cell-cultivated meat and seafood are currently not included in the Codex Alimentarius, which sets global food practices, guidelines, and standards managed by the United Nations World Health Organization (WHO) and Food and Agriculture Organization (FAO) (FAO & WHO, 2025). Hence, no internationally harmonized standards for cell-cultivated products exist. However, the WHO and FAO have organized various roundtable meetings and produced publications on the topic (FAO & WHO, 2023).

Currently, no internationally harmonized term exists for labeling or describing cell-cultivated products (Chriki et al., 2025). The FAO and WHO note that while international harmonization is ideal, the terms used should be linguistically appropriate across different geographic areas and meet regulatory and marketing needs in each country (FAO & WHO, 2023). Of the countries that have approved cell-cultivated products so far and have English as their official language, Singapore requires the use of a qualifying term like "cultured" on the label of these foods (Singapore Food Agency, 2023); Australia and New Zealand require the terms "cell-cultured" or "cell-cultivated" (Food Standards Australia New Zealand, 2025); and Hong Kong notes that labels must be truthful and not misleading, and that the use of term "artificial" may confuse consumers (Centre for Food Safety, 2023). In the United Kingdom (UK), cell-cultivated products are not defined as meat but considered as products of animal origin. Furthermore, no other labeling terminology has been published; the Food Standards Agency refers to cell-cultivated meat as a "cell-cultivated product" (Food Standards Agency, 2025).

In terms of the policy landscape, the U.S. is not the only country facing pushback for cell-cultivated products driven by certain stakeholder interests. Like the U.S. states, EU member countries also have diverse opinions on cell-cultivated products. For example, the Netherlands has made significant public investments in the field (Nationaal Groeifonds, n.d.) and was the first EU country to allow pre-approval tastings of cell-cultivated products under controlled conditions (Cellulaire Agricultuur Nederland, n.d.). Conversely, some other EU countries are not supportive of these products. Italy implemented a ban on cell-cultivated meat in 2023, and one of the driving forces behind the ban was Coldiretti, a farmers' association (Fino et al., 2024). Hungary proposed a ban on cell-cultivated meat in 2024, but the European Commission deemed it unjustifiable and potentially harmful to the single EU market (European Commission, 2024). Unlike Hungary, Italy introduced the ban without consulting other EU member states or the Commission, thereby violating EU procedure (Fino et al., 2024). The ban may therefore be found incompatible with EU marketing rules (Monaco, 2025).

Delegations from Italy, Austria, and France, supported by ten other EU countries, have expressed concerns to the Council of the EU regarding cell-cultivated products. These delegations have requested a broad debate at the EU level addressing ethical, economic, and social considerations (Monaco, 2025; Council of the EU, 2024). The EU currently has a precautionary approach to any novel food products, whereby every cell-cultivated product undergoes a premarket evaluation under the Novel Food framework by the European Food Safety Authority (EFSA), and then, based on the EFSA evaluation, the Commission can authorize or deny the product's commercialization (Lanzoni et al., 2024). To date, no cell-cultivated products have completed the process.

5. Future implications

5.1. Labeling implications on the U.S. market

This analysis of the current regulatory and legislative environments

Table 4
Regulatory approvals for cell-cultivated human food products internationally as of October 2025.

Country	Year	Product	Company
Singapore	2020	Cell-cultivated chicken	GOOD Meat (Eat Just)[a]
Singapore	2024	Cell-cultivated quail	Vow[a]
Israel	2024	Cell-cultivated beef	Aleph Farms[a]
Hong Kong	2024	Cell-cultivated quail	Vow[a]
Australia and New Zealand*	2025	Cell-cultivated quail	Vow[b]
Singapore	2025	Cell-cultivated chicken	PARIMA[c]

*Australia and New Zealand have a shared regulatory authority.
[a] Bamezai & Chapman, 2025.
[b] Food Standards Australia New Zealand, 2025.
[c] Sorrells, 2025.

for cell-cultivated products highlights multiple challenges and considerations regarding how these products will be marketed in the U.S. First, like genetic engineering, nanotechnology, and some other emerging technologies, the development of cell-cultivated products appears to suffer from a lag between innovation and regulatory developments (so-called "pacing problem") (Grieger et al., 2019; Kuzma, 2022; Marchant et al., 2011). This lag suggests a broader challenge of aligning governance structures with fast-moving innovations. The length of the current dual-agency regulatory review process for most cell-cultivated products to determine their safety has been noted to pose challenges for start-up companies whose viability depends on meeting timelines to bring products to market (Marquez et al., 2025). Facilitating a faster safety review of applications by FDA and USDA could decrease the uncertainty for companies. Improvements to current oversight that might reduce review times include increasing process transparency – for example, by providing more information on data requirements, review standards, and expected timelines. Additional transparency about the regulatory process might potentially improve public acceptance of regulatory decisions about the safety of the products.

Second, our analysis shows that, in the absence of unified federal standards on labeling, multiple states have proposed and enacted their own labeling guidance. These laws have largely stemmed from legislators' concerns over consumer confusion in the use of meat terms on plant-based and cell-cultivated products and from efforts to protect the conventional livestock market (Diamantas & Laudon, 2022). Some conventional animal agriculture stakeholders have vocally supported legislation to restrict how these products are labeled, ensuring they are clearly differentiated from conventional meat products (Benson & Greene, 2023; National Cattlemen's Beef Association, 2024).

While it is unclear whether and when federal labeling guidance will be published by the FDA and the USDA-FSIS, the case-by-case reviews and decisions by the USDA to date provide some insight on terms that the federal government likely finds acceptable. The misalignment between these USDA approvals and labeling laws in some states will likely trigger federal preemption to ensure consistent terminology nationwide (Meyer et al., 2020). In similar food labeling cases, when states were the first to regulate labeling for certain food products, and when there were differences among states, Congress got involved. This was the case with bioengineered foods labeling, where states first passed laws requiring the disclosure of genetically modified content (Bickell & Croft, 2020). When these differing state requirements made it difficult for food companies to market their products, Congress stepped in and passed the National Bioengineered Disclosure Law to establish national uniformity (7 C.F.R. Part 66). Congress could similarly step in to ensure national uniformity in labeling for cell-cultivated products by clarifying how federal and state labeling laws will interact (Benson & Greene, 2023). In the absence of Congressional intervention, if cell-cultivated companies were to challenge the state-level labeling laws, they would need to file lawsuits against the state. Such lawsuits may have financial implications for these companies. Based on labeling lawsuits put forth by plant-based companies to date, this litigation process can take months to years to reach resolution (Penn State Center for Agricultural and Shale Law). Demonstrating concrete financial harm may be challenging for companies whose cell-cultivated products have yet to enter the market. Since the preemption clause language in the FFDCA differs from that of the FMIA and PPIA (21 U.S.C. § 343-1; 21 U.S.C. § 678; 21 U.S.C. § 467e), it is possible that courts could have different interpretations of whether a state's labeling requirements are preempted by federal law for cell-cultivated seafood (regulated by FFDCA) than cell-cultivated meat (regulated by FMIA and PPIA).

Even if state-level legislation may be preempted in the future, current inconsistencies may discourage investment in cell-cultivated companies, impede interstate commerce, and further contribute to consumer confusion. Once widely available in the U.S. market, cell-cultivated product supply chains will be complicated if companies have to develop different packaging, product names, and marketing to align with each state's labeling requirements. Maintaining compliance may increase costs for cell-cultivated and other alternative protein companies affected by the legislation (Tao & Razick, 2023). More likely, companies will not establish labels for each state but instead only market in a few states where the same label can be utilized, at least in the short term. These differences may also confuse consumers, as products will need to use different terminology depending on where they are sold.

Further, the negative framing of cell-cultivated products within proposed labeling bills and enacted laws, and the media attention surrounding them, may negatively impact consumer perceptions of these products (Paksheresht et al., 2022). The potential to instigate consumer confusion and influence consumer perceptions may serve as the impetus for such legislative actions. The negative framing and media attention could also contribute to cell-cultivated products becoming the subject of polarized public debates, which may have implications for their acceptance, adoption, and regulation moving forward (Mandel, 2013). The broad societal discussion on various aspects of cell-cultivated products matters for the adoption of these products, as perceptions, emotions, aspects of trust, and transparency are important for consumer acceptance and attitudes toward emerging technologies (Kuzma et al., 2023).

5.2. *Nomenclature considerations*

One of the challenges regarding consumer acceptance of cell-cultivated products may relate to the diverse terminology currently used and the lack of public understanding of the technology and products. For example, state legislators, the media, and other stakeholders continue to use "lab-grown" as one of many terms to describe cell-cultivated products, and consequently, that term is also the most familiar to consumers (Good Food Institute, 2024b). The use of misleading terms can contribute to consumer confusion, impacting their willingness to accept cell-cultivated products (Pakseresht et al., 2022). A widely accepted, nationally (or internationally) used nomenclature may help overcome such hurdles.

In addition to complying with the legal definition for "common or usual name," the term that is chosen for labeling cell-cultivated foods should be acceptable to numerous stakeholders. The term identifying these products should distinguish it from conventional products in a neutral and factually accurate manner, considering its method of production. Additionally, any term used should be the same for any kind of food product produced from cells (i.e., livestock, poultry, game, fish, and seafood) to help ensure accuracy and transparency. Ideally, the term would extend to labeling other potential cell-cultivated food classes, including products like cacao and coffee, and milk extracted from cell culture. These nomenclature considerations are also relevant for other technological developments that produce conventional foods or ingredients through non-traditional processes, including fermentation processes (Sturme et al., 2025). As products from cell-cultivated technologies become more available, future studies may benefit from focusing on distinguishing and comparing the terms "conventional agriculture" and "cellular agriculture," and evaluating perceptions of these terms among agricultural stakeholders as well as consumers. Studies so far have used "conventional" (e.g., Post et al., 2020) or "traditional" (e.g., El Wali et al., 2024) when referring to agricultural livestock; however, the acceptability of these terms has not been evaluated within the farming community in particular. Further, future federal labeling guidance should specify whether and under what conditions cell-cultivated products may use claims commonly applied to meat product labels, such as "antibiotic-free," given that these claims are currently defined by animal agriculture practices. It also should identify how to address products that are mixtures of cultivated cells with other ingredients (i.e. a product with 10 % cell-cultivated chicken biomass and 90 % plant-based ingredients).

5.3. Cell-cultivated ban implications on the U.S. market

While only two states passed cell-cultivated product bans in 2024, five states have enacted laws restricting the manufacture, sale, distribution, and/or funding for these products so far in 2025, suggesting that momentum may be increasing for such legislation. Concurrently, the number of completed cell-cultivated federal regulatory reviews has increased, helping to advance U.S. cell-cultivated market growth. This evolving legislative landscape presents two key areas that require additional research and consideration due to their potential implications on the future role of cell-cultivated products in the U.S. food system.

First, additional research is needed to identify and categorize how legislators and other influential U.S. stakeholders frame their support for or opposition to cell-cultivated legislation within the media discourse. Legislators have provided diverse justifications for supporting these bans, including concerns related to the conventional agriculture sector, food safety, and unknown long-term health effects from consuming these products (Associated Press, 2025; Tex. S.B. 261, 2025; Beck, 2025). However, media articles have indicated that in multiple states, ranchers and meat producers are among those who have vocally opposed bans on cell-cultivated meat, arguing that it is up to consumers, not the government, to decide what foods they can purchase (Ataman, 2025; Beck, 2025). Marquez et al.'s (2025) analysis of media coverage surrounding the approval of UPSIDE Foods Inc. and GOOD Meat's cell-cultivated chicken products in the U.S. indicated a complex media environment, with conflicting narratives on the potential benefits or harms of cell-cultivated meat availability in the U.S. market. These narratives are likely to impact legislator and consumer perceptions of cell-cultivated products and influence the overall policy environment (Marquez et al., 2025). Understanding the motivations and reasoning behind these bans could help clarify and address concerns around cell-cultivated products' place within the future U.S. food system.

Second, state-level cell-cultivated product bans may face legal challenges under federal preemption and the so-called "dormant Commerce Clause," the outcomes of which may have broad-reaching impacts on the legality of these bans. An argument could be made that the USDA and FDA's exercise of their existing regulatory authorities over the assessment of cell-cultivated meat and seafood safety and labeling under the FFDCA, FMIA, and PPIA preempts state attempts to ban the manufacture, sale, or distribution of these products. However, in at least one other instance, a U.S. state succeeded in banning a food product inspected and deemed safe by the USDA for nationwide sale. In 2004, California banned the in-state sale of foie gras produced by force-feeding a bird to enhance its liver size (Cal. S.B. 1520), a law that went into effect in 2012. In 2015, a court briefly overturned the ban, finding that the PPIA preempted the state ban pursuant to the Supremacy Clause of the U.S. Constitution. However, in 2017 and 2022, an appeals court upheld California's force-fed foie gras ban, ruling that the ban did not impose an "ingredient requirement" preempted by the PPIA (*Association des Éleveurs de Canards et d'Oies du Québec v. Becerra,* 2017). This aligns with the initial ruling in *UPSIDE Foods, Inc. v. Simpson,* the case challenging Florida's ban of cell-cultivated meat, in which the court dismissed all four PPIA preemption claims, including two ingredient requirement claims *(UPSIDE Foods, Inc. v Simpson et al.*, 2024*)*.

The Florida and Texas cell-cultivated meat ban cases and the foie gras case also included challenges under the U.S. Constitution's dormant Commerce Clause, which prevents discrimination against or an undue burden on interstate commerce. While in the case of foie gras, the court ruled that the ban did not violate the dormant Commerce Clause, the challenges against Florida and Texas's cell-cultivated meat bans have yet to reach a final conclusion (*Association des Éleveurs de Canards et d'Oies du Québec v. Becerra,* 2017; *Association des Éleveurs de Canards et d'Oies du Québec v. Bonta,* 2022*; UPSIDE Foods, Inc. v Simpson et al.*, 2024*; Wild Type Inc. & UPSIDE Foods Inc. v Shuford,* 2025*)*. The foie gras rulings indicate that, in some instances, legal grounds exist for upholding state bans on federally approved and regulated food products. Regardless of whether Florida and Texas' bans are found to be similar in constitutional terms, these cases will likely be the first rulings on the constitutionality of state-level bans on cell-cultivated products and could impact the future of this novel technology. It will come at a critical time given the increasing number of proposed and enacted state bans.

5.4. U.S. cell-cultivated policy implications globally

The U.S. is a global leader in the development of cell-cultivated products on many fronts, including the number of cell-cultivated companies, the amount of funding available for these products, and the development of a regulatory review process. However, a bipartisan commission exploring the relationship between biotechnology and national security (of which cell-cultivated products is a minor part of the U.S. engagement in biotechnology) issued a report in April 2025 warning that the U.S. may lose its leading position in biotechnology to China, unless the sector is prioritized through additional funding and policies (National Security Commission on Emerging Biotechnology, 2025). Similar recommendations for government investments have been made within U.S.-focused science community reports (Shirwaiker et al., 2024).

The proposed and enacted bans could negatively impact the U.S. investment climate for cell-cultivated meat and seafood and detract foreign companies from establishing operations in the U.S. The regulations and legislation in effect are a key factor for companies determining where to launch new products. Nevertheless, even with some states banning cell-cultivated meat and seafood, considering its population and demographics, the U.S. likely remains a significant market area for cell-cultivated companies (Strategic Market Research, 2024). Cell-cultivated products are not expected to compete with conventional animal products in the upcoming years, as large-scale production will require significant additional capital and infrastructure development. However, with increasing global meat consumption (Searchinger et al., 2019), cell-cultivated products may help meet the growing demand for protein.

5.5. Study limitations

Limitations of this study include ambiguity in interpreting proposed bills, enacted laws, and federal and state regulations. While the authors have reviewed the existing regulations and applicable laws to the best of their abilities, it should be noted that some interpretations are currently under discussion in the courts (e.g., *UPSIDE Foods Inc. v Simpson*) and are thus evolving. Since the landscape of labeling and ban legislation is continually changing, this article offers only a snapshot in time of the proposed bills and enacted laws in the U.S. However, by doing so, this article helps show the complex and evolving U.S. legislative landscape and its implications for cell-cultivated product companies, consumers, and other food system stakeholders.

In this study, we aimed to produce an objective and neutral description of the current regulatory and policy landscape, without taking a standpoint or speculating on different future scenarios. However, all the authors are affiliated with an interdisciplinary research center focused on alternative proteins and acknowledge the potential for implicit biases stemming from personal beliefs or the center's focus.

6. Conclusion

The policy landscape for cell-cultivated proteins in the U.S. is rapidly evolving. This article is novel in its cataloging and description of the current regulatory and legislative environments for cell-cultivated meat and seafood products. We also discuss the implications of legislative actions for the long-term viability of cell-cultivated products in the U.S. and global markets.

We find that, instead of federal regulations specific to labeling these products, many states have proposed and passed laws that differ in how

these products are labeled or in their market access. This patchwork regulatory approach may inhibit interstate and international commerce, present challenges for U.S. cell-cultivated companies commercializing products, confuse consumers, and restrict consumer access to these products in certain states. If the USDA and FDA prioritize finalizing transparent labeling guidance for cell-cultivated meat and seafood, this guidance could preempt the diverse state-by-state labeling framework and provide a cohesive U.S. regulatory environment for these novel products. This study can serve as a comprehensive resource on the policy landscape for cell-cultivated products to inform policymakers, industry leaders, researchers, and other stakeholders in the U.S. and globally. These findings may inform future research on narratives surrounding legislative actions on alternative proteins, as well as on efforts to document the impact of legislation on specific U.S. stakeholders.

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Declaration of competing interest

The authors declare no competing interests.

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Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.tifs.2025.105527.

Data availability

No data was used for the research described in the article.

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