

Food and Agriculture Organization (FAO)

STUDY GUIDE



TOPIC:

**Food Safety Challenges from the
Production of Cell-Based Food**



Table of Contents

1. Introduction to the Committee.....	3
2. Background of the Topic.....	5
3. Key Stakeholders and Positions.....	8
4. Previous UN Actions and Resolutions.....	27
5. Current Challenges and Debates.....	33
6. Case Studies.....	38
7. Possible Solutions and Future Perspectives.....	44
8. Guiding Question.....	46
9. Suggested Readings and Resources.....	47
10. References.....	49

Introduction to the Committee

Mandate and purpose

The FAO (Food and Agriculture Organization) is an international agency that is part of the United Nations. It has the main responsibility and duty of leading international efforts to defeat hunger and ensure food safety worldwide. It also has a strong connection with plenty of the United Nations Reforms regarding food security. There are 195 members, which are 194 countries and the European Union, it also works in over 130 countries worldwide.

This agency also has the responsibility of establishing food security regulations for food with special characteristics such as genetic modifications, specific growth areas, preparations, among other aspects that could affect people's health or diet.

History and role of this committee

This highly important organization was first established in 1945, in Quebec City, Canada. It happened during the first official meeting of the newly created United Nations. Right after that statement, the first temporary headquarters were initiated in Washington D.C.

But FAO isn't all about food, this organization supports Members to implement effective collaborative One Health strategies and capacities, for improving the health of people, animals, plants and the environment. Especially in the agriculture field where it is important to establish specific regulations regarding the use of pesticides and where the crops are allowed to grow.

FAO is deeply connected with the UN's development system (UNDS) where this agency works to guarantee food safety for everyone. To achieve its mandate of ending hunger, FAO collaborates with other UN agencies, funds and programmes, uniting forces and combining respective strengths and comparative advantages (Food and Agriculture Organization of the United Nations, 2022).

Past actions or resolutions related to its functions

The FAO has made significant advances regarding various past issues. According to Cavalletti (2018), the Food and Agriculture Organization has “eradicated the deadly livestock viral disease, rinderpest; created international standards, Codex Alimentarius, to ensure safe, good food for everyone; eliminated human ‘river blindness’ in 11 West African countries”. This is the general view of what the FAO does as an agency regarding the vast number of global issues related to food, nutrition and agriculture.

The Food and Agriculture Organization has also created and implemented an extensive range of programs and projects related to the elaboration of new Special Agriculture Products. Which are more efficient, sustainable and friendly for the environment so there are high quality products that will later be processed in factories.

Background of the topic

Key Terms

- **Cell-Based Food (Cultivated Meat).** Food products made by cultivating animal cells directly in a controlled environment, rather than by raising and slaughtering animals.
- **Food Safety.** Measures and conditions necessary to control hazards and ensure that food is safe to eat and free from harmful contaminants.
- **Bioreactor.** A vessel or system that provides a controlled environment for growing animal cells at scale, mimicking conditions inside an animal's body.
- **Culture Medium.** A nutrient-rich solution used to support the growth and multiplication of cells in vitro. It may contain amino acids, sugars, vitamins, growth factors, and sometimes serum.
- **Contamination.** The unintended presence of harmful biological (e.g., bacteria, viruses), chemical (e.g., toxins, cleaning agents), or physical (e.g., metal shards) substances in food.
- **Pathogen.** A microorganism, such as bacteria or virus, that can cause disease. In cell-based foods, potential pathogens may come from equipment, workers, or the environment.
- **Cross-Contamination.** The transfer of harmful microorganisms or substances from one surface, product, or process to another, possibly leading to foodborne illness.
- **Hazard Analysis and Critical Control Points (HACCP).** A systematic preventive approach to food safety that identifies, evaluates, and controls physical, chemical, and biological hazards during production.
- **Scaffolding (in cell-based food production).** A structure or material used to support the growth and organization of cells into a desired shape or texture, often imitating the structure of real meat.
- **Good Manufacturing Practices (GMP).** Regulations and procedures that ensure food is consistently produced and controlled according to quality standards.
- **Sterility (in cell culture).** The absence of any living microorganisms, which is essential to prevent contamination in the production of cell-based food.

- **Residues.** Traces of substances, such as antibiotics, hormones, or chemicals, that may remain in the final food product and could pose health risks.
- **Traceability.** The ability to track the history, application, or location of a product or its components throughout the production and distribution process.
- **Regulatory Oversight.** The supervision and enforcement of laws and guidelines by government agencies to ensure food safety, labeling, and production standards.

Historical background

The concept of cell-based food, also known as cultivated or lab-grown meat, has its roots in early 20th-century scientific imagination, with Winston Churchill famously predicting in 1931 that humans would one day grow meat without raising animals. Throughout the mid-to-late 20th century, advancements in cell culture technology—primarily for medical and pharmaceutical research—laid the foundation for this innovation. However, it wasn't until 2013 that the world saw its first real breakthrough in cell-based food, when Dutch scientist Dr. Mark Post unveiled a lab-grown beef burger in London. This event marked a significant milestone, proving that meat could be produced without animal slaughter, but it also highlighted a new set of challenges, particularly concerning food safety. Unlike traditional meat production, cultivating meat in a bioreactor involves maintaining strict sterility to prevent microbial contamination, managing the safety of growth media and scaffolding materials, and ensuring consistent quality and genetic stability of the cells. As interest in sustainable food alternatives grew, startups and biotech companies began entering the space, prompting regulatory agencies like the U.S. FDA, USDA, and Singapore Food Agency to develop oversight frameworks to ensure these novel foods are safe for consumption. In 2020, Singapore became the first country to approve the sale of cultivated meat, setting a precedent for others. Today, while commercialization efforts are advancing, food safety remains a primary concern and focal point for both regulators and producers as they work to build public trust and establish industry standards for this cutting-edge food technology.

Major developments leading to the current situation

6

Over the past two decades, several major developments have shaped the current landscape of cell-based food production and its associated food safety concerns. The unveiling of the first lab-grown burger in 2013 by Dr. Mark Post marked a turning point, proving that



animal cells could be cultivated into edible meat. This breakthrough sparked a surge of investment and innovation, leading to the rise of biotech startups like Memphis Meats (now UPSIDE Foods), JUST, and Mosa Meat, all aiming to commercialize cultivated meat. As production methods advanced, the focus shifted from scientific feasibility to issues of scalability, cost-efficiency, and most importantly, safety. Cultivated meat introduced new food safety challenges, such as ensuring the sterility of bioreactors, preventing microbial contamination, and evaluating the safety of novel ingredients like synthetic growth factors and scaffolds. Recognizing these challenges, regulatory agencies began establishing oversight frameworks. In 2019, the U.S. FDA and USDA agreed to jointly regulate cell-based meat, and in 2020, Singapore became the first country to approve the commercial sale of cultivated chicken. These regulatory moves have catalyzed further development while also prompting ongoing global discussions about how to ensure the safety, traceability, and public acceptance of these novel products. Today, the industry continues to grow, guided by emerging regulations and a strong emphasis on addressing food safety from the lab to the table.

Relevant international treaties, conventions, and agreements

Several international treaties, conventions, and agreements are relevant to the regulation and safety of cell-based food production, even though no specific global frameworks exist solely for lab-grown meat. The Codex Alimentarius, developed by the FAO and WHO, provides international food safety standards that influence regulations for new food technologies, including cell-based foods. The World Trade Organization's (WTO) Sanitary and Phytosanitary (SPS) Agreement and Technical Barriers to Trade (TBT) Agreement ensure that food safety regulations are science-based and non-discriminatory, supporting international trade in novel foods. The Cartagena Protocol on Biosafety addresses the safe use of genetically modified organisms, relevant to cell-based food technologies that may involve genetic engineering. In the European Union, the Novel Food Regulation governs the approval of new food products, with guidance from the European Food Safety Authority (EFSA) on assessing the safety of cultivated meat. Additionally, the UN Framework Convention on Climate Change (UNFCCC) indirectly impacts the industry by encouraging sustainable food production methods, which includes the potential of lab-grown meat to reduce environmental footprints. These international frameworks collectively ensure that cell-based foods meet safety standards, promote sustainability, and facilitate global trade.

Key Stakeholders and Positions

Countries

United States of America 	The United States of America has approved of cultivated meat and cell-based food in general. This was done because of the review and approval that the FDA made on companies such as GOOD Meat and UPSIDE foods for their products to be sold to customers. The United States was one of the two countries that approved of the commerce of cell-based food along with the Netherlands. The first approved product was cell-cultivated chicken, and it was sold in restaurants after it passed the regulations established in the report the Congress made related to cell-based food. The National Science Foundation has invested more than 5 million dollars in research projects to find alternatives for food such as beef, pork, chicken, seafood, among others (Benson & Greene, 2023).
Russian Federation 	Russia has recently started acting regarding the production of cell-based food. The company Ochakov Food Ingredients Plant introduced a new meatloaf product made from animal cells and that is extracted from cows. Russia has a specific point of view regarding this topic, especially because the country views cell-based food as a great alternative to avoid massive animal slaughter. The greatest challenge in Russia regarding cell-based food is that it has been complicated to obtain the necessary certifications to allow the sale of products across the country (Eurogroup for Animals, 2019).

People's Republic of China

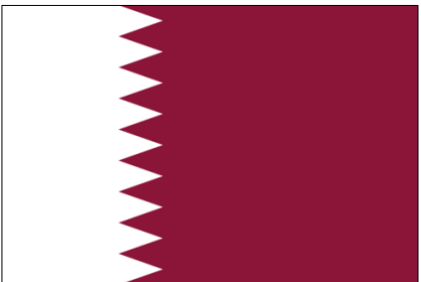


China has made significant progress in addressing food safety challenges, evolving from concerns about food shortages to complex issues involving modern technologies like genetically modified organisms (GMOs) and cell-based foods. Despite enacting various laws—most notably the 1995 Food Hygiene Law—and creating numerous regulations to enhance food safety, enforcement remains fragmented due to overlapping responsibilities among several government agencies. Challenges include foodborne illnesses, weak self-management by producers, the influx of GM imports, and growing consumer demand for safer food. Although initiatives like the Green Food Programme and international standard alignment have improved food safety and trade readiness, inconsistencies in law enforcement and regulatory coordination persist. As China balances rapid food technology development with safety and public trust, strengthening unified regulation and enforcement is crucial for sustainable progress.

French Republic 	The French Republic has taken a cautious and largely oppositional stance toward the production and commercialization of cell-based food, driven by a mix of food safety, cultural, and ethical concerns. In December 2023, French parliamentarians introduced a bill to ban the production, processing, and marketing of cultured meat, aligning with Italy's earlier move and reflecting a desire to protect national agricultural traditions. A government-commissioned report from April 2023 emphasized that cellular foods clash with France's anthropological and cultural views of food, which are deeply rooted in heritage and social identity. Prominent figures, including former Agriculture Minister Julien Denormandie, have criticized lab-grown meat as a misguided scientific endeavor, calling it "paillasse meat" and questioning its role in society. From a food safety perspective, France echoes international concerns highlighted in the joint FAO-WHO report, which outlines risks such as microbial contamination, chemical residues, and allergens in cell-based food production. The report advocates for stringent risk assessments and safety protocols like GMP and HACCP. While countries like Singapore are embracing cultured meat, France remains committed to a more traditional view of food, emphasizing safety, transparency, and the preservation of its culinary legacy.
United Kingdom of Great Britain and Northern Ireland 	The United Kingdom is taking a proactive approach to food safety challenges from cell-based food production. Through a £1.6 million regulatory sandbox program led by the Food Standards Agency (FSA) and Food Standards Scotland (FSS), the UK is working with industry to gather scientific evidence and ensure safety before market approval. Key concerns include nutritional differences, contamination risks, and allergenicity. Consumer skepticism remains, with only 16–41% willing to try cell-cultivated meat, though many see potential environmental and ethical benefits. The UK is also streamlining regulatory processes to support innovation while maintaining high food safety standards.

Republic of Singapore 	Singapore is a global leader in regulating cell-based foods, becoming the first country to approve the sale of cultured chicken in 2020. The Singapore Food Agency (SFA) requires rigorous pre-market safety assessments, evaluating toxicity, allergenicity, and production methods. To support this, Singapore formed the Novel Food Safety Expert Working Group and introduced the Food Safety and Security Bill in 2024 to strengthen oversight. Clear labeling of products like “cultured” or “plant-based” is also mandatory. Singapore’s science-based, transparent approach has been praised by the FAO and WHO as a global model for food safety in the cell-based sector.
State of Israel 	The State of Israel is proactively addressing food safety challenges associated with cell-based food production through a comprehensive, science-driven approach. The Israeli Ministry of Health, in collaboration with the Ministry of Agriculture and the Israel Innovation Authority, oversees the regulation of cultivated meat on a case-by-case basis, focusing on key safety aspects such as microbial contamination, growth media composition, genetic stability of cell lines, and the use of food-grade materials. Israel’s strong biotech ecosystem, bolstered by innovative companies like Aleph Farms and Future Meat Technologies, works closely with regulators to ensure products meet high safety standards before reaching consumers. The country also participates in international regulatory discussions to align with global practices while promoting transparency, public education, and consumer trust through clear labeling and open communication.

Kingdom of the Netherlands 	The Kingdom of the Netherlands, a global leader in food innovation, actively addresses the food safety challenges posed by the production of cell-based foods such as cultured meat. As an early supporter of this technology, the Netherlands emphasizes the need for rigorous oversight of novel production processes, including sterile bioreactor environments and the use of safe, ethical growth media. Key concerns include potential microbial contamination, unknown long-term health effects, and differences in nutritional composition compared to conventional meat. Operating within the EU framework, the Netherlands adheres to the Novel Foods Regulation (EU 2015/2283), requiring comprehensive safety assessments before market approval. The Dutch Food and Consumer Product Safety Authority (NVWA), in collaboration with research institutions like Wageningen University, plays a central role in evaluating and guiding safe development. The government also supports transparent regulation, public engagement, and international harmonization to ensure consumer trust and safe commercialization of cell-based food products.
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Swiss Confederation 	The Swiss Confederation takes a cautious yet forward-looking approach to addressing food safety challenges associated with the production of cell-based food. As a non-EU country with its own regulatory framework, Switzerland applies its Federal Food Safety and Veterinary Office (FSVO) guidelines to assess novel foods, including cultured meat. Key concerns include ensuring the sterility and safety of lab environments, evaluating the toxicity and allergenicity of growth media and scaffolding materials, and confirming the nutritional adequacy and compositional consistency of final products. Swiss regulators emphasize a science-based risk assessment process and closely monitor international developments, particularly within the EU and Codex Alimentarius, to align with global best practices. Transparency, traceability, and labeling also form central pillars of the Swiss approach to building consumer confidence. While cell-based food products are not yet approved for sale in Switzerland, the government encourages innovation through pilot research and maintains open dialogue with industry and academia to ensure that any future market entries meet the country's high food safety and quality standards.
State of Qatar 	Qatar is proactively addressing food safety challenges associated with the production of cell-based foods, recognizing their potential to enhance food security in arid regions. The country has participated in global discussions, such as the FAO and WHO's expert consultations, to identify potential hazards in cell-based food production, including risks related to cell sourcing, growth media, and bioreactor use. Qatar's National Food Security Strategy emphasizes increasing local food production and integrating sustainable technologies. While specific regulations for cell-based foods are under development, Qatar's involvement in international collaborations and its focus on innovative food technologies demonstrate a commitment to establishing robust food safety frameworks for emerging food production methods.

Kingdom of Spain 	The Kingdom of Spain addresses food safety challenges from cell-based food production within the EU's Novel Foods Regulation framework, requiring EFSA approval for market entry. The Spanish Agency for Food Safety and Nutrition (AESAN) works with EFSA to ensure product safety, while national initiatives like the €5.2 million investment in BioTech Foods highlight Spain's commitment to advancing this technology. Public support for cultivated meat is growing, with 58% of Spaniards in favor, provided safety standards are met. Spain continues to develop specific regulations while supporting innovation and consumer protection.
Federative Republic of Brazil 	The Federative Republic of Brazil is actively exploring the potential of cell-based food production, though regulations specific to this sector are still in development. While the country does not yet have dedicated guidelines for cultured foods, its robust food safety system, regulated by agencies like the National Health Surveillance Agency (ANVISA), provides a foundation for managing the associated risks. Brazilian startups, such as Ambi Real Food, are pioneering the development of cell-based meat, and public attitudes are increasingly positive, with over 66% of consumers expressing willingness to try these products. Brazil's commitment to food innovation, combined with its established food safety infrastructure, places it in a strong position to address the challenges of safely producing and regulating cell-based foods in the future.

Republic of Italy 	The Republic of Italy has taken a firm stance against cell-based food production by enacting a ban on the production, sale, and distribution of cultivated meat. Passed in November 2023, the law imposes fines ranging from €10,000 to €60,000 for violations, primarily driven by concerns over protecting Italy's culinary heritage and traditional food practices. While the government argues that lab-grown meat threatens cultural values, the decision has sparked significant criticism from scientists, industry stakeholders, and sustainability advocates. They argue that banning such products undermines progress in addressing climate change and advancing sustainable food systems. The ban has also raised concerns within the European Union, as it was enacted before the EU could complete its own regulatory review of cultivated meats, potentially creating a conflict with EU-wide procedures. This move highlights Italy's balancing act between preserving traditional food values and navigating the challenges of regulating innovative food technologies in Europe.
Dominion of Canada 	Canada is addressing food safety challenges in cell-based food production through a robust regulatory framework. Under the Food and Drugs Act, cell-based foods are treated as novel foods, requiring thorough safety assessments by Health Canada before market approval. The country's strong biotechnology sector, including companies like Because Animals and Future Fields, is driving innovation in cultured products. Key safety concerns, such as cell sourcing and growth media, are being tackled through collaboration between regulators and industry. Health Canada works alongside agencies like the Canadian Food Inspection Agency (CFIA) to evaluate safety, nutritional, and environmental factors. This balanced approach ensures that Canada fosters innovation while maintaining high food safety standards.

Japan 	Japan is developing its regulatory framework for cell-based foods to ensure safety and industry growth. The Consumer Affairs Agency (CAA) is working on safety standards, with guidelines expected by summer 2025. The Japan Association for Cellular Agriculture (JACA) is helping align Japan's regulations with international norms. Starting in April 2024, the Ministry of Health, Labour, and Welfare (MHLW) will transfer food hygiene responsibilities to the CAA to streamline the regulatory process. Consumer interest is high, with 42.2% of Japanese consumers open to trying cultivated meat, provided it is deemed safe. Japan is focused on ensuring transparent safety assessments as it progresses with integrating cell-based foods.
Federal Republic of Germany 	Germany is actively addressing the food safety challenges of cell-based food production within the European Union's regulatory framework. The European Food Safety Authority (EFSA) is responsible for evaluating the safety of novel foods, including those derived from cell cultures. In 2022, a German company, The Cultivated B, became the first to apply for EU approval for a hybrid hotdog that combines plant protein with cultivated muscle cells. On the national level, Germany's Federal Institute for Risk Assessment (BfR) plays a crucial role in assessing the health risks posed by new production methods like cellular agriculture. Germany also follows EU regulations on labeling, ensuring that terms associated with conventional meat cannot be used for cell-based products, allowing consumers to clearly distinguish between traditional and novel food options. Through these efforts, Germany is playing an active role in shaping EU policies on cell-based foods, focusing on rigorous safety assessments, clear labeling, and addressing consumer concerns.

Republic of Korea (South Korea) 	South Korea is developing a comprehensive regulatory framework for cell-based foods to ensure both safety and innovation. In 2023, the Ministry of Food and Drug Safety (MFDS) released guidelines outlining the approval process for cultivated meat products, focusing on safety and public health. The country has also designated a Regulatory-Free Special Zone in Gyeongbuk to encourage research and development in the cultivated meat sector. The approval process involves detailed safety assessments, including cell origins, manufacturing processes, and potential health impacts, with an evaluation period of up to 270 working days. Additionally, labeling guidelines were introduced, prohibiting the use of animal product names like "beef" or "milk" to prevent consumer confusion, though terms like "bulgogi" and "hamburger steak" are allowed if clearly stated. These measures reflect South Korea's commitment to balancing innovation in cultivated meat with stringent safety standards.
Finland 	Finland is addressing food safety challenges in cell-based food production through a combination of national and European efforts. The Finnish Food Authority (Ruokavirasto) ensures high food safety standards through inspections and monitoring. Finland is also advancing cellular agriculture through the CERA-FIM project, which aims to develop sustainable food alternatives like egg whites and animal proteins without traditional livestock. On the European level, Finland actively participates in discussions led by the European Food Safety Authority (EFSA) to assess the safety of cell culture-derived foods. This approach reflects Finland's commitment to ensuring food safety while supporting innovation in the emerging field of cellular agriculture.

Kingdom of Denmark 	Denmark is actively advancing the production of cell-based foods with a focus on innovation and safety. The Danish government supports research, such as projects exploring alternatives to animal serum to reduce production costs for cell-based foods. Consumer preferences are also being considered, with studies showing a preference for terms like "free meat" over "in-vitro meat." Denmark aligns with EU regulations on novel foods, ensuring that cell-based products meet safety standards and are transparently labeled. The country is also attracting international investment, with companies like Remilk planning to build large-scale facilities for animal-free dairy production. Overall, Denmark is balancing innovation with strict safety and regulatory adherence.
United Mexican States 	Mexico currently lacks specific regulations for cell-based food production, with its food safety framework primarily focused on traditional food products. The "Tipo Inspección Federal" (TIF) program oversees the inspection of meat and poultry to ensure safety standards. While Mexico has not yet addressed cell-based foods directly, it has engaged in collaborative efforts with international bodies like the U.S. Food and Drug Administration (FDA) to improve food safety protocols and training. As the regulation of cell-based foods is still emerging globally, Mexico is expected to align with international standards and collaborate with global regulators as it develops its own policies for this new sector.

Republic of Argentina 	Argentina currently does not have specific regulations for the production and safety of cell-based foods, with its food safety framework primarily focused on traditional food products. The Argentine Food Code (CAA), enforced by agencies like the National Service for Agrifood Health and Quality (SENASA), governs the safety and regulation of food and beverages. While there are no regulations yet for cell-based foods, Argentina is actively participating in international discussions and collaborations regarding the regulation of these emerging products. Representatives from Argentina have taken part in global forums, emphasizing the need for international cooperation, knowledge sharing, and stakeholder engagement. As the global regulatory landscape for cell-based foods continues to develop, Argentina is expected to align its policies with international standards, ensuring that it is prepared to manage food safety challenges associated with new food production methods.
Kingdom of Belgium 	Belgium, through the Federal Agency for the Safety of the Food Chain (FASFC), oversees food safety from production to consumption, ensuring compliance with both Belgian and European Union (EU) regulations. The EU's regulatory framework for cell-based foods, such as cultivated meat, is evolving. The European Commission has updated internal guidance to clarify that while Regulation (EC) No. 853/2004 does not specify requirements for these products, they should adhere to general hygiene rules for products of animal origin. The European Food Safety Authority (EFSA) is responsible for assessing the safety of novel foods, including cultivated meat, before they can enter the market. However, the current premarket authorization process has been criticized for its complexity and delays, potentially hindering timely market access for these innovative products. This situation has raised concerns about the EU's role in global food security and its competitiveness in food innovation.

Kingdom of Norway 	Norway is proactively addressing food safety challenges associated with cell-based food production through a combination of regulatory oversight and scientific research. The Norwegian Food Safety Authority (Mattilsynet) and the Norwegian Scientific Committee for Food and Environment (VKM) are central to this effort, conducting risk assessments and providing guidance on emerging food technologies. To advance understanding and development in this field, the Research Council of Norway has funded the "ARRIVAL" project, a five-year initiative launched in 2023, aimed at developing cellular agriculture technologies for producing sustainable food alternatives like milk, eggs, and meat. This project involves collaboration among institutions such as Nofima, SINTEF Industry, Oslo Metropolitan University, and industry stakeholders like TINE AS and Nortura AS. While Norway is not an EU member, it aligns with the European Economic Area's novel food regulations, requiring thorough safety assessments for new food products. Through these combined efforts, Norway is positioning itself at the forefront of ensuring the safety and viability of cell-based foods.
Commonwealth of Australia 	Australia is actively developing a regulatory framework to ensure the safety of cell-based foods. The country's food safety authority, Food Standards Australia New Zealand (FSANZ), is responsible for assessing and approving novel foods, including those produced through cellular agriculture. In December 2023, FSANZ completed its first assessment of a cell-cultured food product—a quail meat developed by Sydney-based company Vow—and determined it to be safe for consumption, noting no health or nutritional risks and a very low risk of bacterial contamination. To streamline the approval process for future cell-cultured products, FSANZ has proposed establishing specific standards that would apply to all such foods, moving away from evaluating each product solely as a novel food. This approach includes clear labeling requirements, recommending terms like "cell-cultured" or "cell-cultivated" to inform consumers. Australia's proactive stance positions it as a leader in regulating and supporting the safe introduction of cell-based foods into the market.

Republic of India 	India is proactively developing a regulatory framework to address food safety challenges associated with cell-based food production. The Food Safety and Standards Authority of India (FSSAI) currently classifies cultivated meat and seafood as "novel foods" under the Food Safety and Standards (Approval of Non-Specified Food and Food Ingredients) Regulations, 2017, requiring pre-market approval for such products. Recognizing the need for a more tailored approach, FSSAI is formulating specific regulations for cell-based foods, drawing insights from international standards to ensure scientific rigor and consumer safety. This initiative aligns with the Indian government's broader commitment to supporting alternative proteins and sustainable food systems. Health Minister JP Nadda has emphasized the importance of regulatory reforms to accommodate emerging food technologies and evolving consumer preferences. By establishing a clear and adaptive regulatory pathway, India aims to foster innovation in cellular agriculture while safeguarding public health.
South Africa 	South Africa is gradually engaging with the regulatory and scientific dimensions of cell-based food production, though its primary focus remains on traditional food safety and agricultural systems. The Department of Agriculture, Land Reform and Rural Development, together with the Department of Health, has acknowledged the importance of aligning with Codex Alimentarius standards in evaluating emerging food technologies. While there is no specific regulation yet for cultivated meat, South Africa recognizes its potential to contribute to food security, especially in addressing protein shortages. Consumer acceptance remains uncertain, but the government has shown interest in participating in FAO and WHO-led consultations on novel foods to build regulatory readiness.

Kingdom of Sweden 	Sweden, as part of the European Union, follows the EU Novel Foods Regulation (EU 2015/2283), which requires European Food Safety Authority (EFSA) approval before market entry. Sweden strongly emphasizes science-based risk assessments and consumer transparency, insisting that new products meet high safety standards before approval. Swedish policymakers and researchers are also concerned with sustainability, seeing cell-based food as a potential complement to climate goals and reduced reliance on intensive livestock farming. However, they stress that consumer trust must be built through clear labeling, public engagement, and rigorous safety protocols.
Türkiye 	Türkiye is beginning to explore the regulatory implications of cell-based food, though no specific legal framework currently exists. The Ministry of Agriculture and Forestry has expressed caution, highlighting the need for extensive research on safety, nutritional adequacy, and consumer impact before allowing commercialization. Culturally, traditional dietary practices and strong agricultural sectors have fueled skepticism toward lab-grown products, but Türkiye is monitoring global developments closely. Participation in FAO consultations and Codex initiatives reflects Türkiye's recognition of the importance of harmonized safety standards for future trade and innovation.
Republic of Chile 	Chile has positioned itself as a regional leader in biotechnology and alternative proteins in Latin America. The Chilean Agency for Food Safety and Quality (ACHIPIA) has expressed openness to exploring frameworks for cell-based food regulation, while emphasizing consumer safety, traceability, and alignment with international standards. Chile also participates in Codex Alimentarius discussions, recognizing that harmonized global rules are essential for international trade. With a strong export-oriented food industry, Chile views cultivated meat and seafood as both an opportunity and a challenge: an opportunity to expand sustainable markets, but a challenge in ensuring food safety and gaining public trust.

New Zealand 	New Zealand, in partnership with Food Standards Australia New Zealand (FSANZ), is actively developing regulatory frameworks for cell-based food. FSANZ treats these products as <i>novel foods</i>, requiring rigorous pre-market safety assessments, including studies on microbial risks, toxicology, and nutritional equivalence. New Zealand policymakers highlight the importance of consumer transparency and mandatory labeling to distinguish cultivated products from conventional ones. Public discussions reflect cautious optimism, with many seeing potential sustainability and animal welfare benefits. New Zealand's proactive role in regional and international food safety dialogues signals its commitment to both innovation and consumer protection.
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The positions of different regional groups

African Union (AU)

In February 2025, the African Union adopted the statute for establishing the Africa Food Safety Agency (AFSA) during the 38th Ordinary Session of the Assembly of Heads of State and Government in Addis Ababa, Ethiopia. This agency aims to coordinate and harmonize food safety policies, regulations, and risk assessment frameworks across member states, addressing the continent's disproportionate burden of foodborne illnesses. While the AU has not specifically addressed cell-based foods, the establishment of AFSA indicates a commitment to strengthening food safety governance, which could encompass emerging food technologies like cell-based food production.

European Union (EU)

The European Food Safety Authority (EFSA) is responsible for evaluating the safety of novel foods in the EU, including those derived from new technologies such as cell culture and tissue engineering. As of now, EFSA has not received any applications for cell-culture-derived foods but anticipates such applications in the future. EFSA is preparing by updating its scientific guidelines to assess the safety of these new food technologies, ensuring that they are ready to evaluate such products when applications are submitted.

Association of Southeast Asian Nations (ASEAN)

ASEAN has been prioritizing food safety as a critical component of its Post-2015 Health Development Agenda for 2021-2025. The region faces significant public health and economic burdens due to foodborne illnesses. To address these challenges, ASEAN is working on strengthening regional food safety systems through continuous development, ensuring compliance with regional policies, improving safe food environments and supply chains, and enhancing consumer empowerment on food safety. While specific policies on cell-based foods are not detailed, these initiatives lay the groundwork for addressing the safety of emerging food technologies.

Middle East and North Africa (MENA) Region

In the MENA region, there is a significant gap in food safety levels and control systems compared to developed nations. This disparity poses challenges for the safety of fresh produce and agricultural practices, hindering progress in international food trade. While specific positions on cell-based foods are not detailed, the region's focus on improving food safety standards and practices is crucial for addressing the challenges posed by novel food technologies.

Intergovernmental and Organizations (IGOs)

The Food and Agriculture Organization (FAO)

The United Nations plays a central role in evaluating and guiding global food safety approaches, especially for novel food technologies like cell-based food. In collaboration with the World Health Organization (WHO), the FAO has taken proactive steps by releasing scientific reports that examine the potential food safety risks associated with cultured meat and seafood. These reports highlight biological, chemical, and environmental hazards, and propose risk assessment strategies to ensure safe production. The FAO also supports governments in building the regulatory capacity necessary to evaluate and monitor cell-based food production and provides a neutral platform for international policy dialogue.

The World Health Organization (WHO)

24

Complements the FAO's work by focusing on the public health implications of cell-based food. It participates in joint expert consultations to assess health risks, nutritional



adequacy, and long-term impacts on consumer health. WHO also emphasizes the importance of consumer education and transparent communication to foster trust in new food technologies. Its involvement ensures that the global public health dimension remains at the core of discussions on cell-based food safety.

The Codex Alimentarius Commission (CAC)

Established by the FAO and WHO, develops internationally recognized food standards, guidelines, and codes of practice. Although Codex has not yet finalized specific standards for cell-based foods, its role is crucial in setting a regulatory benchmark that countries can adopt or harmonize with. By providing such guidance, Codex enables safer global trade in cell-based products and ensures that food safety measures are consistent and science-based across regions.

Non-Governmental Organizations (NGOs)

The Good Food Institute (GFI)

Is a leading nonprofit organization that advocates for alternative proteins, including plant-based and cultivated (cell-based) meat. GFI actively collaborates with companies, researchers, and regulators to advance safe, scalable cell-based food production. It provides detailed technical guidance, white papers, and regulatory support to help producers meet safety standards. GFI also engages in public policy efforts to ensure that regulations evolve alongside scientific advancements, and it funds research aimed at identifying and mitigating food safety risks throughout the production process.

Consumers International

A global federation of consumer rights organizations plays an essential advocacy role in ensuring that consumer interests are represented in policy discussions around cell-based food. The organization emphasizes the importance of clear labeling, transparent communication, and consumer engagement to build trust in this emerging sector. Consumers International calls for rigorous safety evaluations and standards to ensure that all novel foods, including those produced using cellular agriculture, are safe, ethically produced, and accessible.

The International Union of Food Science and Technology (IUFoST)

Contributes by fostering scientific research and collaboration across academic and industry sectors. IUFoST brings together food scientists, technologists, and institutions to address the technical and safety challenges associated with cell-based food production. The organization supports knowledge sharing and education, helping to ensure that safety protocols are based on the latest scientific insights and best practices. It also plays a key role in preparing the next generation of food scientists to navigate the complexities of emerging food systems.

Previous UN Actions and Resolutions

Relevant past UN resolutions, treaties, and policies related to the topic

Codex Alimentarius Commission – Food Safety Standards

The Codex Alimentarius Commission, established in 1963 by the Food and Agriculture Organization (FAO) and the World Health Organization (WHO), is the primary international body responsible for setting food safety and quality standards. Although Codex has not yet issued specific guidelines for cell-based foods, it provides the essential framework that many countries use to regulate food safety. The commission is currently exploring how to address the safety, labeling, and trade implications of novel foods like cultured meat. Codex standards are recognized by the World Trade Organization (WTO) and play a critical role in harmonizing food safety regulations globally, which is vital for the development, acceptance, and trade of cell-based food products.

UN General Assembly Resolution A/RES/74/242 (2019)

Adopted in 2019, UN General Assembly Resolution A/RES/74/242 focuses on “Science, Technology and Innovation for Sustainable Development.” The resolution emphasizes the importance of advancing scientific innovation while ensuring environmental, social, and public health protections. Though it does not specifically mention cell-based food, it provides political support for the adoption of emerging technologies—including those in agriculture and food production—under safe, inclusive, and sustainable frameworks. This resolution is often referenced in discussions surrounding the regulatory readiness and ethical governance of novel food technologies, such as cultured meat.

FAO-WHO (2023) Expert Report – Food Safety Aspects of Cell-Based Food

In 2023, the FAO and WHO released a landmark expert report titled “Food Safety Aspects of Cell-Based Food.” This was the first comprehensive international document to specifically address the food safety considerations of cell-based meat and seafood. The report outlines potential biological, chemical, and production-related hazards, and provides guidance on risk assessment, production monitoring, and regulatory best practices. It serves as a scientific foundation for countries developing national policies and regulations for the safe

commercialization of cultured foods. This report is widely recognized as a key step in integrating novel food technologies into global food systems.

Sustainable Development Goals (SDG 2 & SDG 12)

The United Nations Sustainable Development Goals (SDGs), adopted in 2015, include multiple goals that relate directly to food safety and innovation. SDG 2 aims to achieve “Zero Hunger,” advocating for improved agricultural productivity, sustainable food systems, and enhanced food safety. SDG 12 focuses on “Responsible Consumption and Production,” which includes reducing food waste and improving sustainability in food processing and distribution. While the SDGs do not mention cell-based food specifically, the principles they promote align closely with the potential benefits of cultured meat—such as reducing the environmental impact of meat production and ensuring a safer, more controlled food supply.

Cartagena Protocol on Biosafety to the Convention on Biological Diversity

The Cartagena Protocol on Biosafety, adopted in 2000 under the Convention on Biological Diversity (CBD), addresses the safe handling, transfer, and use of living modified organisms (LMOs), primarily focusing on genetically modified organisms (GMOs). Although cell-based foods are not genetically modified in the traditional sense, the protocol's principles—such as the precautionary approach, risk assessment, and public participation—are relevant to emerging biotechnologies, including cellular agriculture. The Cartagena Protocol encourages member states to develop national biosafety frameworks and promotes international cooperation in evaluating and managing the risks of novel technologies, making it indirectly applicable to the regulation of cell-based food.

FAO/WHO Guidelines on Novel Foods and Technologies (Ongoing Work)

The FAO and WHO are currently in the process of updating international food safety guidelines to address the challenges and considerations of novel food technologies, including cell-based food. This ongoing work aims to fill current regulatory gaps by establishing scientific protocols for evaluating the safety of foods produced through cellular agriculture and other emerging techniques. The guidelines will help countries develop harmonized regulatory systems and ensure that these products meet safety standards before entering markets. As cultured food technologies advance, these guidelines will serve as a critical reference for national and regional regulatory bodies tasked with assessing novel food safety risks.

How effective these measures have been in addressing the issue

Codex Alimentarius Commission

The Codex Alimentarius Commission has laid a solid foundation for global food safety standards, and its influence is visible in how many countries shape their national food laws. However, when it comes to cell-based food, its lack of specific guidelines has delayed consistent international regulation. Although Codex is working toward addressing novel foods, the pace has been relatively slow, leaving many regulatory bodies to develop their own interim approaches, which leads to fragmentation and regulatory uncertainty. Nonetheless, Codex's reputation and authority make it a key player in eventually standardizing safety assessments for cell-based products.

UN Resolution A/RES/74/242

This resolution has been symbolically important, as it affirms the UN's support for innovation in sustainable development, including food production. However, its effectiveness is limited in practical terms, as it is non-binding and lacks specific implementation mechanisms. It doesn't address food safety directly, nor does it provide a framework for evaluating the risks of technologies like cell-based food. Its main contribution has been in creating a supportive policy climate for scientific innovation, which indirectly benefits cellular agriculture by encouraging investment and research.

FAO-WHO 2023 Report on Cell-Based Food Safety

This report is arguably the most effective and practical initiative to date in directly addressing the food safety aspects of cell-based food. It has provided a clear framework for risk assessment, production safety, and regulatory considerations, offering countries a technical guide for developing their own standards. It has been praised for being scientifically rigorous and forward-looking. Several governments and regulatory agencies are already using this report to inform their national policies, which shows early signs of success in harmonizing global approaches. However, its full impact will depend on how broadly it is adopted and whether it evolves alongside technological developments.

Sustainable Development Goals (SDGs 2 & 12)

The SDGs have been inspirational and guiding principles in aligning innovation with sustainability and food security. They have helped frame cell-based food as a tool for reducing environmental harm and improving food access. However, the SDGs do not provide specific actions or enforcement mechanisms. Their success depends on how countries interpret and act on them. In practice, they have helped advocate for sustainable food innovation but have had limited direct impact on food safety regulation for cell-based products.

Cartagena Protocol on Biosafety

The Cartagena Protocol has been very effective in setting precedents for the safe use of biotechnology, especially GMOs. However, its relevance to cell-based food is indirect, since most cultured meat products do not involve living modified organisms. Nevertheless, its risk assessment frameworks and precautionary principles have been influential in shaping how novel food risks are evaluated. Its effectiveness in directly addressing cultured food safety is limited, but it offers a useful model for future biotechnology governance.

FAO/WHO Guidelines on Novel Foods (In Progress)

These upcoming guidelines hold strong potential for effectiveness, but their impact cannot yet be measured. Once released, they are expected to provide the first unified, science-based safety protocol for a wide range of novel foods, including those made using cellular agriculture. If adopted widely, these guidelines could significantly improve regulatory clarity and consumer safety across countries. Their future effectiveness will depend on political will, industry compliance, and international cooperation.

Challenges in implementing previous solutions

- **Lack of Specificity in International Guidelines.** One of the major challenges in implementing previous solutions is the absence of specific, binding international standards tailored to cell-based food. While bodies like Codex Alimentarius provide broad food safety guidelines, they have yet to issue concrete standards for cultured meat and seafood. This gap leaves countries to interpret and apply general food safety principles on their own, resulting in inconsistent and fragmented regulatory approaches. The lack of

specificity makes it difficult for regulators, especially in developing nations, to assess risks accurately or establish appropriate safety protocols for novel food products.

- ***Slow Policy Adaptation and Regulatory Lag.*** Regulatory and intergovernmental bodies tend to move at a slower pace than technological innovation. While the FAO/WHO 2023 expert report was a significant step forward, it arrived years after startups and research labs had already begun producing cell-based prototypes. Many existing food safety regulations were designed for conventional agriculture or genetically modified organisms (GMOs), and don't align well with the unique processes involved in cellular agriculture. This lag results in regulatory uncertainty, deterring investment and slowing the commercialization of these products.
- ***Resource and Capacity Constraints in Developing Countries.*** Low- and middle-income countries often lack the technical expertise, funding, and institutional infrastructure to implement the complex risk assessment and oversight mechanisms proposed by international bodies. Although FAO and WHO provide capacity-building support, it's not always sufficient or timely. These resource constraints make it challenging for many countries to adopt even well-designed food safety frameworks, leaving gaps in global oversight and potentially widening inequalities in food innovation and access.
- ***Public Perception and Consumer Trust Issues.*** Many of the previous solutions, especially those rooted in science and policy, have underemphasized public engagement and education. As a result, there is widespread skepticism and misunderstanding about the safety and ethical implications of cell-based food. Negative public perception can hinder political momentum, delay regulatory acceptance, and make it difficult for producers to bring products to market. Building consumer trust requires clear labeling, transparency, and sustained public communication—elements that have not been sufficiently prioritized in earlier policies.
- ***Jurisdictional Overlap and Policy Incoherence.*** Another major challenge is the overlap between national, regional, and global food safety authorities, which can lead to policy duplication or conflict. For example, a product approved in Singapore might not meet the safety standards of the European Union or the United States. Without a cohesive, harmonized approach, companies face complex and costly approval processes in each market. This lack of coordination undermines the effectiveness of international guidance and creates obstacles for global trade and innovation in the cell-based food sector.

- ***Incomplete Data and Scientific Uncertainty.*** Cell-based food is a relatively new field, and many long-term health, environmental, and production impacts are still unknown. This makes it difficult for regulators to fully implement solutions that depend on comprehensive risk assessment. The limited availability of standardized data on ingredients, growth media, and production methods complicates efforts to ensure safety and develop universal benchmarks. Without robust, peer-reviewed scientific evidence, even the most carefully crafted policies may be built on assumptions or outdated models.

Current Challenges and Debates

The primary obstacles preventing resolution of the issue

1. **Regulatory gaps and lack of global harmonization.** One of the most significant obstacles is the absence of comprehensive and harmonized international regulations specific to cell-based food. While countries like Singapore and the United States have started to develop frameworks, most regions still rely on outdated or generic food safety laws. This regulatory patchwork creates uncertainty for producers and investors, who may face different safety requirements, approval timelines, and labeling rules in each market. The lack of a unified global approach not only hinders international trade but also slows down the adoption of cell-based food technologies.
2. **Limited scientific data and long-term research.** Another major hurdle is the insufficient amount of long-term scientific data on the safety, nutritional content, and potential health effects of cell-based foods. As a relatively new field, cellular agriculture still lacks a robust, standardized body of research that regulators can rely on to assess risks. Additionally, much of the existing data is proprietary, held by private companies that may be reluctant to share findings due to competitive concerns. Without transparent, peer-reviewed studies, it is difficult to make informed policy decisions or earn public trust in the safety of these products.
3. **High production costs and technical barriers.** Producing cell-based food safely at scale remains technically challenging and expensive. Maintaining sterile environments, ensuring batch consistency, and preventing microbial contamination are all critical but complex processes. These technical and logistical issues make it harder to guarantee food safety and meet regulatory standards. Until production technologies are refined and scaled, ensuring the safety of every product will remain a costly and intensive process—limiting accessibility and broader acceptance.
4. **Public skepticism and low consumer awareness.** Public perception remains a major barrier to the acceptance and regulation of cell-based food. Many consumers are unfamiliar with how it's produced and are concerned about its "unnatural" nature, potential health risks, and ethical implications. Misconceptions and fear can lead to resistance from the public, politicians, and even food safety regulators, who may be

hesitant to endorse or approve products without strong public backing. Without proactive education and transparent communication, consumer mistrust will continue to delay progress.

5. **Ethical, religious, and cultural concerns.** The production of cell-based meat also raises complex ethical and cultural questions, particularly regarding religious dietary laws (such as Halal and Kosher certification), the use of animal-derived cells, and philosophical views on "natural" food. These issues can delay regulatory acceptance in regions where cultural or religious traditions strongly influence food laws. The lack of consensus on how to classify or label these foods complicates safety assessments and market approval processes.
6. **Intellectual Property and Industry Secrecy.** The commercial nature of the cell-based food industry means that many companies keep their processes and safety data confidential, citing intellectual property concerns. While understandable from a business perspective, this secrecy makes it difficult for regulators and researchers to conduct transparent, independent safety evaluations. It also slows down collaborative scientific advancement and the development of universal standards, which are critical for ensuring consumer protection and public health.
7. **Weak institutional capacity in many countries.** Finally, many low- and middle-income countries lack the institutional infrastructure and technical capacity to regulate advanced food technologies like cell-based meat. These countries may not have trained food safety experts, testing laboratories, or up-to-date laws that accommodate such innovations. This creates global disparities in regulation and access and could lead to regulatory loopholes or safety risks in less-prepared regions.

Different perspectives on how to address these challenges

Government and Regulatory Authorities' Perspective

Governments and food safety regulators typically advocate for a science-based, risk assessment approach to address the challenges. They emphasize the need for clear regulatory frameworks, rooted in the precautionary principle and international cooperation. Regulators call for updating existing food laws, creating guidelines specifically for cell-based food, and working with international bodies like Codex and FAO/WHO to harmonize safety standards

globally. Many also support public consultation and transparency to enhance consumer confidence. However, some governments, especially in lower-income regions, stress the need for technical assistance and capacity-building support from global institutions.

Scientific and Academic Community's Perspective

Scientists advocate for a rigorous, evidence-driven approach to ensure safety while encouraging innovation. They call for more independent, peer-reviewed research into the long-term health, nutritional, and environmental impacts of cell-based food. Many researchers argue that data sharing—including from private sector studies—should be encouraged or even required to build a shared scientific foundation for regulation. Some also highlight the importance of developing standardized testing methods and safety protocols, which can be used across countries to speed up evaluation and approval processes.

Cell-Based Food Industry's Perspective

Industry leaders tend to emphasize the need for regulatory clarity, efficiency, and flexibility, arguing that prolonged or uncertain approval processes can stifle innovation. They push for collaborative frameworks where governments and companies work together to develop practical safety standards. The industry often supports voluntary transparency, such as publishing safety data or undergoing third-party audits, but also seeks protection for proprietary methods. Many companies believe that early engagement with regulators, open communication, and investment in public education can help address both safety and trust concerns.

Consumer and Public Health Advocacy Perspective

Consumer groups and public health advocates stress the importance of transparency, independent oversight, and ethical considerations. They want clear labeling, strong post-market surveillance, and publicly accessible safety data. Many are cautious about industry self-regulation and call for government-led safety testing and long-term monitoring of health impacts. They also emphasize consumer rights and choice, advocating for policies that include cultural, ethical, and religious sensitivities, especially when labeling products as “meat” or “natural.” Some also raise concerns about food justice and call for ensuring equitable access to safe cell-based foods.

International Organizations' Perspective

Organizations like the FAO, WHO, and Codex Alimentarius take a neutral, facilitative role, promoting international consensus and capacity-building. They focus on developing guidelines, training, and technical support to help countries regulate cell-based food effectively. Their approach centers on global harmonization, minimizing trade barriers, and encouraging both food safety and innovation. These bodies often stress the importance of inclusive, science-based dialogue among governments, industry, and civil society, recognizing that global coordination is essential for addressing the shared challenges of novel food systems.

The implications of the issue for international security, human rights, and economic development

Implications for International Security

Food safety challenges related to cell-based food production could impact international security by affecting global food trade, trust in transboundary regulatory systems, and biosecurity. As cell-based food enters international markets, inconsistent safety standards can lead to trade disputes, especially if one country deems a product unsafe while another permits its sale. Additionally, the risk of contamination or biotechnological misuse (e.g., tampering with cell cultures) poses emerging biosecurity concerns. If these technologies are not securely regulated, they may be exploited or mishandled in ways that undermine public health or cause diplomatic tensions. Coordinated international safety protocols are thus critical for maintaining stable global supply chains and preventing cross-border health crises.

Implications for Human Rights

From a human rights perspective, food safety in the context of cell-based production is tied to the right to safe, nutritious, and culturally appropriate food. If these products are introduced without adequate safety oversight, it could infringe on individuals' rights to health and bodily autonomy. Moreover, labeling and transparency are essential to uphold consumer rights and informed choice. There's also a growing discourse around ensuring that vulnerable populations, including those in developing countries, are not excluded from access to safe

innovations. Equity in both safety regulation and food distribution will be essential to avoid creating new divides in food security and rights fulfillment.

Implications for Economic Development

Economically, cell-based food has the potential to be a transformative innovation, but unresolved safety concerns can slow its development and limit its impact. Without robust safety standards, consumer confidence may remain low, deterring investment and market adoption. On the other hand, effective regulation can accelerate growth, attract international partnerships, and position countries as leaders in food innovation. For developing nations, the challenge is even greater: they risk falling behind in biotechnology adoption due to limited regulatory capacity and infrastructure. However, if properly supported, they could benefit from job creation, sustainable food production, and reduced reliance on imports—all of which contribute to broader economic resilience.

Case Studies

Specific historical or contemporary case studies relevant to the topic

Case Study 1: Singapore – The First Country to Approve Cultivated Meat (2020)

In 2020, Singapore became the first country in the world to approve the sale of a cultivated chicken product by the U.S.-based company GOOD Meat. The Singapore Food Agency (SFA) developed a novel food regulatory framework that included pre-market safety assessments, toxicological data, and production process validation. This marked a historic moment in food safety governance, setting a global precedent. The regulatory process emphasized sterility, absence of contaminants, and nutritional adequacy. However, it also exposed some key challenges: the high costs of production limited accessibility, and the lengthy safety review process highlighted the need for streamlined but rigorous regulatory pathways. Singapore's experience shows that government readiness and scientific capacity are essential to managing novel food safety risks.

Case Study 2: United States – Dual Oversight Model (FDA + USDA, 2022–2023)

The U.S. established a dual-agency regulatory framework where the FDA oversees cell collection and cultivation, while the USDA oversees processing and labeling of meat products derived from cellular agriculture. In 2022 and 2023, the FDA cleared cultivated chicken products from Upside Foods and GOOD Meat, concluding that the products were safe for consumption. However, this approach highlighted coordination challenges between agencies, with concerns about overlapping jurisdictions and the complexity of splitting responsibilities. The case also exposed gaps in consumer education and labeling, which remain contentious. This model demonstrates that while robust safety reviews are possible, regulatory clarity, transparency, and inter-agency collaboration are essential to avoid confusion and delays.

Case Study 3: Israel – Innovation Leadership, Regulatory Uncertainty

Israel is home to many leading cellular agriculture startups, such as Aleph Farms and Future Meat Technologies, and has become a hub for innovation in this space. However, despite strong scientific advancement, Israel lacks a formalized regulatory framework specifically for cell-based foods. This has created uncertainty for companies trying to bring

products to market. The lack of defined food safety standards tailored to this technology has delayed domestic approvals and forced companies to focus on international markets like the U.S. and Singapore. Israel's case shows that innovation alone is not enough—regulatory systems must evolve in tandem to ensure safety, market readiness, and public trust.

Case Study 4: FAO/WHO Global Expert Consultation (2022–2023).

In response to growing global interest in cell-based food, the FAO and WHO convened a joint expert consultation to assess food safety risks and provide guidance for regulators worldwide. The 2023 report, *“Food Safety Aspects of Cell-Based Food,”* identified potential hazards in production stages, such as microbial contamination, use of growth factors, and unintentional chemical residues. This consultation did not involve a commercial product but acted as a case study in proactive policymaking. It showed how international collaboration, and scientific foresight can help anticipate safety issues before they become widespread concerns, though implementation across countries remains uneven.

Case Study 5: Netherlands – The First Cell-Based Burger (2013)

In 2013, the Netherlands hosted the unveiling of the world's first cultivated beef burger, developed by Maastricht University with funding from Google co-founder Sergey Brin. While the product was not commercially sold, the event generated global attention and sparked early discussions about safety, regulation, and ethics. The lack of an established safety protocol at the time prevented the burger from entering markets. The case highlighted the gap between scientific achievement and regulatory preparedness, underscoring the need for parallel development of innovation and safety oversight. Today, Dutch startups still face a regulatory vacuum, although the government supports funding for research and commercialization.

Similar issues handled by the international community

Genetically Modified Organisms (GMOs)

The introduction of GMOs in the 1990s and 2000s faced many of the same hurdles now seen with cell-based food: public skepticism, scientific uncertainty, labeling controversies, and regulatory fragmentation. The Cartagena Protocol on Biosafety (2000), adopted under the UN Convention on Biological Diversity, was a key step toward international coordination. It

allowed countries to make decisions based on precautionary principles, emphasizing risk assessments and public transparency. However, despite global efforts, GMO regulation remains deeply divided, with regions like the EU maintaining strict controls, while others (e.g., U.S., Brazil) embrace GMOs widely. The GMO experience shows that lack of global consensus and diverging values can lead to long-term policy fragmentation, trade friction, and public mistrust—challenges now echoed in the cell-based food landscape.

Nuclear and Radiation Safety in Food (Post-Chernobyl and Fukushima)

After the Chernobyl (1986) and Fukushima (2011) nuclear disasters, there was heightened concern over radioactive contamination of food supplies. The international community, led by the International Atomic Energy Agency (IAEA) and Codex Alimentarius, quickly established safety thresholds for radionuclides in food and water. These crises prompted stronger coordination and rapid mobilization of scientific resources, setting a precedent for global food safety response systems. The key lesson here is that in the face of potential public health risks, clear global standards and crisis communication are crucial. While cell-based food isn't a disaster-driven issue, this example demonstrates how urgency and transparency can unify global action.

Novel Foods Regulation in the European Union

The EU's Novel Foods Regulation (1997, revised in 2015) was developed in response to emerging food technologies, including new ingredients, nanofoods, and alternative proteins. It created a centralized system for pre-market authorization, risk assessment by the European Food Safety Authority (EFSA), and mandatory labeling. Although this approach has been criticized for being slow and bureaucratic, it offers a robust model for ensuring food safety without stifling innovation. The EU's experience highlights the importance of a centralized, transparent regulatory body and consumer involvement in decision-making—strategies that can be adapted for cell-based food regulation worldwide.

Melamine Contamination Crisis (China, 2008)

In 2008, the discovery of melamine-laced milk products in China led to a massive food safety scandal, sickening hundreds of thousands of children. The scandal revealed weak enforcement, poor traceability, and lack of international oversight. In response, China reformed its food safety laws and began participating more actively in Codex Alimentarius and

WHO food safety efforts. This crisis underscored the need for strong enforcement, international accountability, and transparency—core concerns for cell-based food as well. It also showed that economic development alone doesn't guarantee food safety; effective governance and cultural shifts toward safety-first thinking are critical.

Aquaculture and Seafood Safety

As aquaculture rapidly expanded in the 2000s, concerns arose over chemical use, antibiotic residues, and heavy metal contamination in farmed fish. International bodies like FAO, WHO, and Codex developed specific guidelines for veterinary drug residues, foodborne pathogens, and water quality in seafood production. This collaborative, science-based approach helped stabilize international trade and establish minimum safety thresholds, even in countries with limited regulatory capacity. The aquaculture model offers useful parallels for cell-based meat, where water-based bioreactors and contamination risks also require technical and hygiene standards.

Lessons learned and their implications for future resolutions

Public Trust is as Important as Scientific Safety

One of the most important lessons from the introduction of genetically modified organisms (GMOs) and the melamine contamination crisis in China is that public perception plays a vital role in the success of any food innovation. Despite scientific consensus on the safety of many GMOs, a lack of early transparency and public education led to skepticism and outright rejection in several countries, particularly in Europe. Similarly, the melamine crisis severely eroded public trust in food systems, highlighting how a single incident can have long-lasting reputational consequences. These cases show that even when products are proven to be safe, public acceptance hinges on clear communication, transparency, and trust in institutions. For cell-based food, this underscores the importance of proactive consumer education, transparent labeling, and inclusive communication strategies that involve communities and address ethical and cultural concerns.

Fragmented Regulation Creates Long-Term Problems

41

The global experience with GMOs also illustrates the complications of fragmented regulatory systems. Different national and regional stances on the regulation and labeling of



GMOs have resulted in significant market segmentation and trade disputes. The same pattern is emerging with cell-based food, where countries like the United States and Singapore have established approval pathways, while others, such as in the European Union, remain cautious or undecided. This regulatory inconsistency slows innovation, complicates global trade, and makes international consensus difficult. Moving forward, harmonizing food safety standards for cell-based food will be essential. International bodies like Codex Alimentarius, FAO, and WHO can play key roles in developing unified guidelines to ensure product safety while facilitating global market access.

Science-Based, Proactive Risk Assessment Works

Crises involving nuclear contamination, such as those following Chernobyl and Fukushima, as well as the growth of aquaculture, have demonstrated the value of early, science-based risk assessments. In both cases, international organizations responded by establishing clear contamination thresholds and safety guidelines, which helped stabilize public confidence and maintain food trade. These examples prove that preemptive, evidence-based regulation can manage emerging food safety threats effectively. For the cell-based food sector, this means investing in detailed scientific research to identify potential biological and chemical hazards early, and incorporating these findings into the regulatory framework before products are widely available to the public.

Crises Can Accelerate Reform—But Prevention is Better

Historical food safety failures, such as the melamine crisis in China, often lead to rapid policy reform, but usually only after significant harm has been done. In China's case, sweeping reforms were implemented following the crisis, including stronger enforcement and traceability systems. However, these reforms came at the cost of public health and economic trust. The key takeaway is that prevention is far more effective—and far less costly—than crisis response. In the context of cell-based food, governments and industry players must prioritize early risk mitigation strategies, including quality control, supply chain monitoring, and facility inspections, to prevent incidents before they arise and ensure consumer safety.

Inclusive Governance Enhances Legitimacy and Effectiveness

42

The European Union's approach to regulating novel foods, including alternative proteins and biotechnology, has emphasized centralized, transparent, and inclusive



governance. Although sometimes criticized for its slow pace, the EU's process involves risk assessment from the European Food Safety Authority (EFSA) and consultation with stakeholders across the food chain. This inclusive model builds public trust and strengthens the legitimacy of food safety decisions. Applying this approach to cell-based food regulation means engaging a diverse set of actors—scientists, regulators, industry, civil society, and consumers—to create policy that reflects societal values and is resilient to future challenges.

Possible Solutions and Future Perspectives

National and Regional Approaches

Different countries are experimenting with regulatory pathways. The United States has adopted a dual-agency model (FDA + USDA), while Singapore pioneered a pre-market approval system for cultivated chicken. The EU operates under its Novel Foods Regulation, and nations such as India and South Korea are drafting tailored frameworks. Each approach offers lessons in balancing innovation with safety, yet also highlights risks of fragmentation. Future perspectives point to the need for convergence, either through Codex Alimentarius standards or mutual recognition agreements.

Innovative Policy Recommendations

Policymakers are beginning to explore beyond traditional regulation:

- Regulatory sandboxes, like the UK's, allow real-time testing of safety protocols before mass commercialization.
- Public-private partnerships could accelerate independent research on allergenicity, microbial risks, and long-term health impacts.
- Adaptive labeling policies that distinguish between "cultivated," "cell-based," or "lab-grown" foods can reduce consumer confusion and support informed choice.

Role of International Cooperation

Since food supply chains and trade are global, harmonization is essential. The FAO–WHO 2023 Expert Report laid the groundwork for unified safety assessments, but wider adoption is needed. Collaborative risk assessments, capacity building in developing countries, and shared databases of safety data would enhance trust and transparency. A future-oriented perspective envisions Codex Alimentarius issuing binding standards for cultivated foods, like those already in place for GMOs and veterinary residues.

Strengthening Public Engagement

Scientific safety alone will not ensure adoption. Public skepticism—rooted in cultural, ethical, or religious concerns—remains strong. Effective strategies include transparent communication campaigns, consumer education programs, and consultation with religious authorities to address halal/kosher certification. Trust-building is not a one-time solution but an ongoing process tied to equity, labeling, and post-market surveillance.

Industry-Led Standards and Best Practices

The private sector can contribute by adopting voluntary global standards for Good Manufacturing Practices (GMP), Hazard Analysis and Critical Control Points (HACCP), and traceability. Initiatives by organizations like the Good Food Institute show how industry collaboration can accelerate both safety and acceptance. In the future, third-party certification schemes—like “organic” or “fair trade” labels—may emerge for cell-based products.

Long-Term Outlook

If effectively regulated and communicated, cell-based foods could reshape global food systems by reducing environmental footprints, ensuring food security, and diversifying protein sources. Yet, unresolved questions remain: What are the long-term health impacts? How will small and developing economies integrate into this sector? Looking forward, success depends on interdisciplinary solutions that merge biotechnology, ethics, law, and international diplomacy.

Guiding Questions

1. Understanding the problem

- What are the main causes of food safety concerns in cell-based food production?
- What unique safety risks do cell-based foods pose compared to conventional meat?

2. Historical and global context

- How has the international community responded to this issue so far? (e.g., FAO/WHO reports, regulatory actions by the U.S., Singapore, EU)
- What lessons can be learned from the regulation of other novel foods (e.g., GMOs, plant-based meat)?

3. Barriers to progress

- What are the key challenges in implementing effective food safety solutions globally?
- How do cultural, economic, and technological differences between countries affect implementation?

4. Roles and responsibilities

- What role should international organizations (e.g., FAO, WHO, Codex Alimentarius) play in ensuring safety and coordination?
- How can developed countries support capacity building in low- and middle-income countries?
- What is the private sector's responsibility in ensuring transparency and safety in cell-based food production?

5. Forward-looking strategy

- What policies or frameworks should be prioritized at the international level to address these challenges?
- How can global cooperation be improved to promote safe innovation and equitable access to cell-based foods?

Suggested Readings and Resources

UN official documents

- **FAO/WHO – Food Safety Aspects of Cell-Based Food:**
This is the most comprehensive UN report to date, covering food, safety risks, terminology, production processes, and global regulatory approaches for cell-based food.
<https://www.who.int/publications/i/item/9789240070943>
- **FAO – Regulatory Frameworks for Cell-Based Food:**
Outlines the legal and institutional landscape in various countries and offers guidance on a regulatory development. <https://www.who.int/publications/i/item/9789240070943>
- **FAO – Cell-Based Food Production Process and Safety Hazards:**
Analyzes the production steps and identifies where food safety hazards may occur.
https://www.fao.org/fao-who-codexalimentarius/sh-Timetable_template%20SE8.pdf
- **FAO – Food Safety News and International Collaboration on Cell-Based Food:**
Covers international meeting, including those with Near East countries, on building regulatory systems and technical capacity. <https://www.fao.org/food-safety/news/news-details/en/c/1651213/>

Academic articles or books

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Websites

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- **Codex Alimentarius (FAO/WHO):** The global food safety standards platform. <https://www.fao.org/fao-who-codexalimentarius/en/>
- **European Food Safety Authority (EFSA):** Science-based risk assessment of new food products in the EU. <https://www.efsa.europa.eu>
- **The Good Food Institute (GFI):** non-profit promoting alternative proteins including cultivated meat, with research and safety updates. <https://gfi.org>
- **New Harvest:** A research Institute focused specifically on cellular agriculture science and policy. <https://www.new-harvest.org/>

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