

Perceptions of Cellular Agriculture
Key Findings from Qualitative Research

Submitted to:

The Environmental Law Institute and New Harvest

By Hart Research Associates

January 2017

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Methodology

On behalf of the Environmental Law Institute and New Harvest, Hart Research Associates conducted two focus groups to understand the **American public's** attitudes regarding cellular agriculture and explore reactions to recent and anticipated developments that will result from its application.

The two focus group sessions were conducted in Baltimore, Maryland, on December 7, 2016. One group was made up of 10 individuals with less than a four-year college degree and the other group included 10 individuals with a four-year college degree or higher. Each group comprised a mix of individuals of different genders, ages, incomes, and races/ethnicities. Participants also were screened to represent diverse religious affiliations, and some are not affiliated with any religion.

The same discussion guide was used in both sessions, in which participants shared their top-of-mind impressions of cellular agriculture and cultured meat, as well as their impressions of cellular agriculture after being provided information about this area of science. Participants reacted to arguments for and against the use of cellular agriculture, and discussed their preferences for which entities might provide regulatory oversight of these developments.

These sessions provide an important qualitative perspective on uninformed and informed impressions of cellular agriculture, and how the public weighs the potential benefits and risks of this field of scientific development. However, the number of participants in these groups is not large enough to generalize key findings from this research to the entire population of American adults. These findings should instead be considered a rich and contextualized glimpse into the **public's attitudes toward** cellular agriculture. While the nature of discussion varied between the two groups, these differences are not enough to draw conclusions about how attitudes vary by level of educational attainment or other characteristics.

Overview

- These audiences are not familiar with the term “cellular agriculture” or developments in this area.
- However, participants make inferences about this field of scientific study based on its name. They make a variety of associations, mentioning the following words, among other things: manmade, farming, GMOs, cloning, labs, and cellular phones. They make associations and inferences that relate more to crops than livestock, and their uninformed feelings about cellular agriculture are mixed.
 - **While they associate some of the same words with “cultured meat,”** participants have a more negative reaction to the term.
- Participants quickly identify several potential benefits and risks from the development of cellular agriculture, and the discussions fluctuate between optimism about how it can make life better and concern about potential adverse consequences.

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- While there are several messages in support of cellular agriculture, testing reveals that the most effective arguments for pursuing this field of study are those that focus on a) increasing the meat supply to meet the **demands of the world's growing population** and b) **eliminating the need** for antibiotic use in livestock.
- The most effective arguments against cellular agriculture are a) that animal products made this way could be unpredictable and harmful to human health, b) that cultured meat could increase allergies and food intolerances because it is made in a lab, and c) that it could put traditional agriculture out of business and lead to job losses and economic harm.
- After hearing about applications for cellular agriculture (some currently in use and some in development), the tone of the discussions becomes more positive, though different applications generate a range of reactions. Applications that have been in use for decades and thus have a proven track record without harmful effects (e.g., to produce insulin and rennet) are viewed more favorably and generate more optimism about cellular agriculture—particularly insulin because of the positive impact it has had on human health for several decades. On the other hand, applications in development for food production (milk and meat) are greeted with greater ambivalence. Cultured meat generates the most questions and concerns, and this application meets the most resistance.

Key Findings

- 1. Cellular agriculture is a term and area of science with which these participants are not familiar. They make some inferences about what it entails based on their understanding of the words, focusing more on crops than livestock. Their general impressions based on the terminology alone are mixed.**

None of the participants had heard of cellular agriculture before the sessions. Most relate it to scientific research in some way, with some relating the terms manmade, lab-grown, and GMO, and some thinking of cell phones. Below are some specific words and phrases that come to participants' minds when they hear the term "cellular agriculture."

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|-----------------------|------------------------------------|
| ❖ Manmade | ❖ Medical |
| ❖ GMOs | ❖ Land development |
| ❖ Cell phones | ❖ Climate change |
| ❖ Good science | ❖ Science fiction |
| ❖ Farming | ❖ Test tubes |
| ❖ Biology | ❖ Unnatural |
| ❖ Gene manipulation | ❖ Molecular growth and development |
| ❖ Growth | ❖ Enhancements |
| ❖ Plant cloning | ❖ Harvesting |
| ❖ Genetic engineering | ❖ Modified meat |
| ❖ Lab-grown food | ❖ Sustainable food supply |

General reactions to the term “cellular agriculture” are mixed. On the positive side, participants mention cellular agriculture’s scientific possibilities, such as providing a food supply to meet the world’s growing population needs, developing foods that can grow in sub-optimal conditions, and increasing agricultural efficiency and production.

“It's just possibilities.”

– Baltimore non-college graduate

“The ability to grow crops in not normal conditions, even something as simple as growing something in a desert. So the ability to create a food product that can grow in Ethiopia. You know, in an environment where it probably shouldn't, but to feed people. I'm sorry if it doesn't have all the carbohydrates you need, but you eat.”

– Baltimore non-college graduate

“And I came from a different country. I came from Burma. It's called Myanmar. It's between India and Thailand. And we are not making enough as used to be, even we're not keeping up, and we're not the only country that's not keeping with either technology or climate change. Something to come over to an efficient way to make more food, also a safer way. . .”

– Baltimore college graduate

“I'm concerned because I know that we need to do this because the planet is . . . we're reaching the over limit with the population, so we have to feed all these people. Our water is getting, there's a big shortage. And my only concern would be that I feel that they really need to do better research, better studies.”

– Baltimore non-college graduate

However, many participants fear that cellular agriculture gets away from the basics and are concerned that its outcomes are unknown. They worry that it is untested and wonder what long-term effects it will have on humans.

“That's what I just thought, they were getting away from the basics, stuff growing in the ground and feeding the animals what they used to, the stocks or whatever that they used to feed them, and now they're injecting them. You know, leaving the basics.”

– Baltimore non-college graduate

“Like I just thought about food, and it sounds like a pretty intense thing to do with your food. If I went to the grocery store and saw those cellular agricultured, I probably wouldn't buy that...Because I don't know what it means.”

– Baltimore college graduate

“. . . I think the biggest concerning part is where does it stop? I don't think the meat, the food, any of that is the issue. I think it's the great, the only concerning part to me is we've all seen the movies . . . I, Robot, and now, we're getting a whole lot closer to all of this artificial . . . human stuff, actually cloning. So my only concern is the precedent becomes set when we do accept this finally. . . So when this becomes acceptable, it really opens the door for something that I'm not sure I agree with to become acceptable.

– Baltimore non-college graduate

"The scientists who come up with these ideas of cloning the fish, with this to create a tomato, what's the effect on the human beings? That's my big concern. Because like I said before, with the children, their bodies have changed, I mean, completely from when we grew up. And they're eating the same thing, but there are more chemicals and more preservatives in these foods, and what is it doing to them?"

– Baltimore non-college graduate

2. Participants also are not familiar with the term “cultured meat,” but they easily form ideas about what they think it means. They tend to have a more negative initial reaction to this term than to “cellular agriculture.”

The discussions reveal that participants generally find the term “cultured meat” unappealing and associate it with processed meat, preservatives, and genetic engineering, among other things listed below:

- ❖ Processed meat
- ❖ Petri dish
- ❖ Manmade
- ❖ Manufactured
- ❖ Vegan/vegetarian
- ❖ Cloning
- ❖ Enhanced meat
- ❖ Famine reduction
- ❖ Hormones
- ❖ High salt content
- ❖ Loss of vital nutrients
- ❖ Preservatives
- ❖ Meat generation from modified DNA
- ❖ GMO
- ❖ Exposed meat
- ❖ Livestock
- ❖ Non-organic
- ❖ Not from an animal
- ❖ Grown in a lab
- ❖ Unnatural
- ❖ Seasoning meat with chemicals
- ❖ Unsafe

Many say the concept of cultured meat is unappetizing. Participants strongly prefer the term “clean meat” over “cultured meat,” although clean meat is not necessarily a good term and causes some to think of meat that is bleached.

"Cellular agriculture sounded a whole lot better once you put up cultured meat."

– Baltimore college graduate

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"I think cultured meat just does not sound like something you would want."

– Baltimore college graduate

"...It's heavily, manufactured meat, I mean, processed meat that has so many chemicals in it to keep it fresh for longer periods of time on the shelf. Just sounds disgusting."

– Baltimore non-college graduate

"Petri dish is the first thing that popped in my head, just not appealing. The thought is not appealing."

– Baltimore non-college graduate

"I didn't know what to think, really. I had two images in my head. I had, you know, Slim Jims and...the aged steaks [that] would cost \$60 or \$70. So I didn't know."

– Baltimore college graduate

"I thought about engineered meat, and I started thinking about meat like Spam."

– Baltimore college graduate

3. Upon reading a description of cellular agriculture (see Appendix B), participants identify both benefits of and concerns about this new area of science. They have several questions about its implications and the potential unintended consequences of the development's application.

Participants react positively to cellular agriculture's potential benefits to food access, improved safety of the food supply and resulting benefits to human health, reducing animal cruelty, and sustainability.

- Participants think that an important benefit of cellular agriculture is its potential to address **food supply** needs in developing countries. This is a benefit expressed particularly strongly by some in the college-educated group. Some of them are quick to note that they would not be interested in consuming cellular agricultural products themselves, yet they recognize the real benefit this could provide to countries and people without adequate food supplies. None perceive a real need for an expanded supply of meat in the United States now, and only some talk about the need for it far in the future.
- The **impact on human health** through the potential elimination or minimization of E. coli, mad cow disease, and other illnesses also is a recurring theme in the discussions.
- In both groups, participants point to the benefits of **reduced animal cruelty**, with some more focused on this issue than others.
- They also anticipate that cellular agriculture could lead to **improved environmental sustainability** by increasing the efficiency of food production while reducing the need for as much land and resources.

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"We're in a world that's starving. And just because here in America we have fewer people who are starving and we don't see them doesn't mean that we don't need some sort of protein. And I think that's very important. It would also be nice for the vegan and vegetarian people to get some protein that perhaps is meat-like, although not been meat since that first cell."

– Baltimore college graduate

"Because either you eat this or you die. That's the moral situation. A lot of places are facing that kind of situation. So I don't think they will even question anything, taste or texture or color or whatever."

– Baltimore college graduate

"I think helping eliminate like the animal disease, avian flu, mad cow, so on, so forth."

– Baltimore non-college graduate

". . . You can probably eliminate even E. coli at some point . . ."

– Baltimore non-college graduate

"I'd rather eat a steak grown in the lab than to know that a cow was...I'm no vegetarian, but to know that I wouldn't create suffering for a different animal."

– Baltimore college graduate

"I've seen cows living in some, and chickens living in some terrible conditions. If it's grown in a Petri dish, it never lived in that condition. It didn't wallow around in its own feces...things like that."

– Baltimore non-college graduate

". . . reproducing cells in a plant to create more hardy crops or sustainable crops."

– Baltimore non-college graduate

Discussion of concerns gravitates toward effects on human health and safety, focusing especially on risks that may not yet be known, though participants also raise other concerns.

- Some are concerned that cellular agriculture products, especially cultured meat, are **not natural**. In their view, it is not the same as the meat that comes from an animal.
- Many worry about the **long-term repercussions** of humans ingesting products that some participants perceive as unnatural and inorganic. Rather than having specific concerns, it is more a concern of what is not known or proven to be safe.
- Some see cellular agriculture as a slippery slope on the road to **cloning**.
- Effect on **taste** also is a concern.
- Some participants predict a potential **disparity between society's "haves" and "have nots,"** where the "haves" can afford to purchase meat from real

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livestock, which they anticipate will be more expensive (and possibly better tasting than cultured meat).

- Scientific advancements also could transform the agriculture industry, resulting in **lost jobs** for farmers and workers who transport livestock and feed for livestock.

"Oh, just along with like long-term effects and everything, I sort of feel like almost we would be like guinea pigs to everything, all the new things they would be coming up with, and we wouldn't really know the side effects that we would get."

– Baltimore non-college graduate

"You could only say that cloning, that this could be a slippery slope down that path . . . that would be fantastic if we can grow organs for people who need it. But I feel like that could just lead us down a path where . . ."

– Baltimore college graduate

"How long before creating meat in the lab becomes so cost effective that raising meat becomes not an option or only an option that the rich can afford? Because if you can create them in the lab, mass produce it without the cost of raising, killing, and moving to market, all of it, all the process of where you may create a few jobs in the automation of growing it, you reduce all the farmers and the farm laborers and the truckers and all that. So all those people are gone. And then all of a sudden, this meat is so readily available, so easily affordable, the option of having real meat becomes, or grown meat becomes not an option at all or an option only for the very wealthy, so . . ."

– Baltimore non-college graduate

"I'm assuming that this mass production on this one will cut down a lot of human jobs."

– Baltimore college graduate

"My concern would be the flavor of this. And in a cow, it comes down to what they eat. Kobe beef, it's what they eat. Veal, it's what they eat. If you're not feeding it, how, what is that, is it going to taste?"

– Baltimore non-college graduate

While participants' discussion of safety tends to focus on potential harms, they acknowledge two sides to the argument: cellular agriculture could create more allergies due to over-sterilization, but it also has the potential to minimize or eliminate diseases.

When asked what they think about potential benefits vs. potential risks after reading the basic information in Appendix B, reactions are mixed. In the college-educated group, more participants lean toward benefits, while the opposite is true among non-college-educated participants. College-educated participants tend

toward a head-over-heart reaction, even though some are turned off by these types of foods and say they would not want to eat them personally.

A few key questions surface for participants after reading a basic overview of cellular agriculture, including the following:

- How will the cellular agriculture process work?
- What will happen to existing livestock?
- How will it affect jobs and the economy?

When asked how far they think we are from seeing these products in stores and restaurants, some assume it already is happening today if there is a focus group discussion about it.

4. Upon viewing a brief animated video from New Harvest that introduces cultured meat, participants express a desire for more information about the process with less emphasis on persuasion.

The video provokes some unease and elicits questions about exactly how cultured meat is produced and how it differs from cloning. Without a more detailed explanation of the process, participants tend to fill in the gaps with their own ideas. The discussions reveal that some participants question if it is really the same meat, despite the video's claim of "same meat, different process."

"It didn't have much information. Like I feel like it should have had more. It was really simple. I just, it's a weird way to introduce that because it's like a big, scary topic."

– Baltimore non-college graduate

"The video was kind of like cutesy, cartoon, like, oh, look how positive this can be. But it doesn't really mention anything negative. It just says, for more information go to this website. But are you really going to do that? Probably not."

– Baltimore non-college graduate

"So basically, when something grows, cells divide because it's fed by blood or something nutritious, and that's the whole thing we're, I think everybody is struggling with. What's causing, when you're outside of a body just sitting on a lab table, what's causing that to happen, I guess? It's hard for us, I guess, to imagine that that can happen outside of, you know, a bio system of a person or a cow or an animal or something that's living"

– Baltimore college graduate

"Now it's coming from a Petri dish, it's coming from a culture, it's coming from tissues that were merged together and then grown inside an incubator or whatever it's going to be grown into, and now you're going to ask me to eat it. It just doesn't, you're going to have to explain that process to a lot of people, and they're going to want to know what that process is. And I think when you start explaining all that, it's going to take a long time for people to look at that and say, hmm."

– Baltimore college graduate

"I think, I wouldn't have any problem with this if I could be really assured that they're using a true genetic, the true genetic code, not, you know, shortcutting...Because then, I mean, that's science. I mean, if you can guarantee that you're doing it, you know, by the code, the true code, then there probably would not be a difference between that cow or the [cultured meat]..."

– Baltimore non-college graduate

5. Participants have more favorable impressions of cellular agriculture upon learning how it is currently used or could be used in the future, but they are more positive toward some applications than others.

When it comes to potential applications for cellular agriculture, participants tend to be more comfortable with and supportive of using it for the development of non-food animal products (e.g., leather and fur) than for food animal products (e.g., meat, milk, and eggs). The discussions suggest that it may be easier to approach the conversation initially by focusing on cellular agriculture as relates to milk and eggs rather than meat, though some participants raise concerns about all types of food products that would be created using cellular agriculture.

Of the four applications described to participants, the description of the medical application of using microbes to produce the human form of insulin for diabetes treatment (Appendix C, item 1) is received most positively—universally so. This is both because of the benefits to human health and the fact that it has a track record of success that began in 1978.

The use of genetically engineered bacteria to produce rennet to turn milk into curds and whey generates few concerns across the groups. Approval by the FDA in 1990 conveys the fact that this is how most cheese making is done today and makes most participants generally comfortable with this application.

The other two food-related applications—brewing milk using yeast cultures that have been genetically inserted with blueprints for milk protein and growing cultured beef from stem cells (Appendix C, items 2-4)—elicit more mixed reactions, particularly from the college-educated group. Participants worry about safety, texture, and taste, but they are more receptive to using cellular agriculture to make milk than to produce meat. Several express concerns over whether such foods will be labeled clearly. At the same time, participants in both groups remain hopeful about the benefits of these developments.

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"The cheese enzyme has been around for over 25 years now. So nobody took a bite of cheese and dropped dead in 25 years. I'm okay with that. But then there's the hamburger one, in 2013, that's been grown in a lab. So, you know, still need to, for me, I would still just like to see a lot more about that...more research, more information, more safety data, more, you know, benefits versus drawbacks for future production and use."

– Baltimore non-college graduate

"The second one I seem to be okay with because to me cheese is a processed thing. It's not something that was a living thing that you eat. So this to me is you're intaking something that's already been processed. So this is just a different way of doing the process."

– Baltimore college graduate

"Like the insulin and the milk production, that seemed a lot less cruel, to not keep a cow in the lactating state sounds really cruel actually."

– Baltimore non-college graduate

"Maybe it's all in the naming...say you have soy milk and almond milk, you have almond juice and you have soy juice. It's not really milk, they just call it milk today. And maybe that's the problem we're having here is they're making something new and they're calling it the same thing as something else. And maybe if it was introduced under a different name or different product, it would be more acceptable to people, because we already have a fixed notion of what milk is, what an egg is, and what meat is."

– Baltimore college graduate

"I guess like everybody, number one, I put great on the first thing because if you get a, seems like to me, an unending supply of insulin. That's a win. That's fine. The two and three was just okay because, like I said earlier, I already kind of figured they were doing it with milk and with all the substitute dairy products. I'm still iffy about four. But I don't eat beef anyway, real beef. So that wouldn't appeal to me, but I want the opportunity to choose between a real burger, and I just want that opportunity to choose."

– Baltimore non-college graduate

"But the last one...made me, like, not want to eat any kind of hamburgers."

– Baltimore college graduate

Overall, participants are more optimistic about the potential benefits of cellular agriculture after hearing about these applications. Those who changed their minds say they did not realize that some of these processes already are used widely, and they see the potential for a cultural shift making them more acceptable.

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"It's already here. It's happened. They just have to go through the formalities. I wasn't even thinking it was that close. I'm thinking, hmm, past 10 years or something. But after reading this, I'm like, wow. I take insulin, so that's why I was like, wait a minute."

– Baltimore non-college graduate

- 6. Of the eight potential benefits of cellular agriculture tested in the discussions (see Appendix D), the ones that participants feel are most important are a) that it will revolutionize the supply chain of animal products to meet the world's growing appetite for meat and b) that the sterile process by which meat can be made using cellular agriculture will reduce the growth of antibiotic-resistant bacteria.**

The following statement resonates with participants because of their concerns about global hunger and overpopulation. College-educated participants are particularly moved by this statement, as it speaks to the case they make early in the discussion about the need to expand the food supply, particularly in the developing world, even if cultured meat is not appealing to them personally.

It is estimated that by 2050, global demand for animal products will have increased by 70% to feed 9.5 billion people. Cellular agriculture has the potential to revolutionize the supply chain of animal products to provide affordable, safe, and sustainable food to meet the world's growing appetite for meat and other animal products. (Appendix D, item 1)

"We just always hear, like, statistics about how our population is going to outgrow the resources that we have, you know, whether it's food or water. And it's going to eventually reach a crisis point. But I think at least in terms of food supply, number one addresses it, it's extremely important, a potential issue in the future."

– Baltimore college graduate

Amid concerns about health and safety, most participants also see the ability to keep antibiotics out of meat as a positive development. Several mention concerns about increased antibiotic resistance and the challenges that it creates for treating illness and disease.

The use of antibiotics in food-producing animals—to fight disease and help the animals grow faster—has been identified as a source of antibiotic-resistant bacteria that is dangerous to humans, and the FDA has reported steady increases in the use of antibiotics in livestock in recent years. Because cultured meats would be produced in sterile environments, these antibiotics would not need to be used. (Appendix D, item 4)

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"Well, it's good not to have the antibiotics in the food. I mean, because there's so much in all the meats that are out there, unless you're really paying attention to what you're buying . . . It's already been proven that our bodies are not able to use antibiotics to fight off colds and things like that because we have so much of it in our system already that it's useless."

– Baltimore non-college graduate

The benefit of having safer food products free of dangerous bacteria as a result of cultured meat being produced in sterile environments resonates with some participants. An opposition argument that comes at this theme from a different angle—that increased allergies and food intolerances are created by overly antiseptic environments—gains more traction, however. Thus, the following message could generate some pushback.

Because cultured meats would be produced in sterile environments, cellular agriculture products would offer a safer, purer product than their traditional counterparts. They would be free of dangerous bacteria that the Centers for Disease Control and Prevention estimates are the most common sources of fatal food-related infections caused by the contamination of conventional meat.
(Appendix D, item 3)

Of all participants, only two self-identify as vegetarian, but several see the benefits of reducing animal cruelty.

"I am a meat lover. But, yeah, if there was a way for that not to have to take place, especially not a torturing situation. If they could be done, just done without any kind of pain longer than a second, I'm semi-okay with that, at least at the dinner table."

– Baltimore college graduate

Arguments about cutting down on waste from animal parts and reducing greenhouse gas emissions, while not necessarily received negatively, do not stand out as much as seemingly more pressing issues such as food access and food safety concerns. Some question whether waste produced from cellular agriculture product factories or the energy resources required might cancel out benefits of not raising livestock.

"Because now you need factories and everything else to produce this, which is going to consume energy on its own, they all could have different drawbacks when it comes to pollution and use of energy and things like that."

– Baltimore college graduate

Few are moved by the argument that cellular agriculture grants the ability to design and tune agriculture products to do things such as reduce saturated fats in meat or remove cholesterol in eggs. Indeed, it is important to note that this argument runs

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counter to the message of “same meat, different process” and could tap into concerns about a slippery slope toward genetically modified foods and/or cloning.

- 7. Of the seven reasons *not* to encourage cellular agriculture that were tested in the sessions (see Appendix E), the ones that gain the most traction are those that highlight that a) animal products grown in a petri dish might behave in unpredictable and harmful ways that could harm human health, b) meat grown in a lab could exacerbate the growing problem of overly antiseptic environments leading to more allergies and food intolerances, and c) it could lead to job losses.**

Fear of unknown consequences dominates the conversation around the risks of cellular agriculture. Participants point to weakened immune systems resulting from overuse of antibiotics and bad reactions to medications that have not been tested adequately as indicators of potential trouble. Arguments that animal products grown in a lab will not taste the same and will have lower nutritional value take a back seat to concerns about the impact on health.

“But to me, it would take 20 years of some community ingesting this meat and seeing that some of the effects of what it had before I would feel comfortable eating it.”

– Baltimore non-college graduate

“I think in general, any process that we're trying to control runs a certain risk of error. I mean, it's just like anything else. Anything we produce, anything we manufacture where there's a human element or even an automated element, I think there's room for error there.”

– Baltimore non-college graduate

“Kids now are sicker than they used to be, than we were as kids. I mean, kids are sick all the time. My kids are sick all the time. I have a 25-year-old son, and then I have the 10-year-old and the nine-year-old, and my 25-year-old was never sick, never. My little kids now are sick all the time. And I feel like it's what they eat, like the environment around them. Everything is just so manufactured and produced and packaged and everything that this, I just feel like kids are sicker.”

– Baltimore college graduate

And while they see the benefits of revolutionizing the agriculture industry to improve food access and industrial efficiency, they worry about the traditional agriculture jobs lost as a result.

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"If you're living in less educated centers and you're living where the job placement, like you were saying, it can make jobs in chemistry and engineering and whatever, well, the amount of people that study that and things like that maybe don't outweigh the amount of farmers that there are and people who work on farms."

– Baltimore college graduate

"Less truckers and less people going to get food elsewhere. It's going to be more local."

– Baltimore non-college graduate

The moral, ethical, and religious implications of cellular agriculture are mentioned briefly as having potential for pushback in conservative and religious communities. This concern was not a focus in among these participants, however.

"One could say you're kind of playing God. But then the other side of that is you're enabled to create ways to make life better. So there's a dilemma there on how you look at that and how you view that. And I think that's been the dilemma with stem cell research is the same issue, the same topic, which is in that same vein."

– Baltimore college graduate

After examining both the risks and benefits, participants are more likely to feel neutral about cellular agriculture. Most indicate either that they still think the benefits are greater, or that the risks and benefits are about equal. Thus, by the end of the discussions, fewer participants feel that the risks of cellular agriculture outweigh the benefits and more express ambivalence.

- 8. There is a clear and strong desire for full study and monitoring of potential risks of cellular agriculture—particularly potential unintended consequences. While participants do not have a strong sense of what the structure of oversight for this field of research should be, there is a consensus that various entities from government (FDA, USDA), NGOs (consumer watchdog groups), scientific bodies (National Science Foundation), and university scientists and researchers should ALL play a role and provide checks and balances. These audiences see a role for a variety of bodies in overseeing advances in cellular agriculture, especially those who are knowledgeable about it.**

After brainstorming who they think should be involved in the regulatory process, participants were given a list of entities that could play a part in determining and managing potential risks related to cellular agriculture (see Appendix F). The US Food and Drug Administration, USDA, NGOs and consumer watchdog groups, and scientific bodies stand out to participants as key potential players. Some see NGOs as more neutral bodies, and others argue that while individual NGOs may have an agenda, at least a variety of voices are brought to the table. The FDA is seen as **strict in its regulations, which increases participants' confidence, but** they worry about corruption and susceptibility to politics for government bodies as well as

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university scientists, depending on their funding streams. A handful of participants in the non-college-educated group also wonders whether there might be a role for organizations that represent farmers.

"Because they [FDA] do have pretty strict policies. Like you always hear about them, like, denying new products because of small, or, you know, it seems like they have a pretty strict code, and they try to enforce it, and it's backed up by science."

– Baltimore college graduate

"But with, the US Department of Agriculture, their only problem, the reason I wouldn't have given them a higher rating, and I think I gave them an eight, is the agenda. You know, their concern would be to preserve the ability of agriculture and growth."

– Baltimore non-college graduate

"Universities are funded, their research labs are generally funded by grants from particular industries. So I don't trust that as much as I would trust an independent scientific body that might not have an allegiance somewhere."

– Baltimore college graduate

"I'm not sure what the group would be, but some representation from the farmers' side of things. Is there a union group of some sort?"

– Baltimore non-college graduate

No participants rate the US Congress, companies that are developing foods using cellular agriculture, or popular or renowned chefs as their top choice for entities in which they have the most confidence to play a part in regulating advancements in cellular agriculture.

Strategic Considerations

The discussions highlight some potential opportunities and cautions for developers of cellular agriculture to consider as they communicate with the general public about this area of science:

- A key step to building support for cellular agriculture and cultured meat among the general public will be providing lay audiences with a simple overview of the process that clearly explains how the resulting product is the "same meat." A lack of understanding around the scientific processes behind synthetic foods plays a major role in sparking concern about whether cellular agriculture food products really are the same as the traditional versions of these products. A lack of information can lead some to fill in knowledge gaps with their own assumptions about the involvement of GMOs and cloning and question whether it really is the "same meat, but a different process."

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- **Beware of challenges in using the term “cultured meat.”** It is a problematic term that generates a negative reaction from many and raises concerns.
- Illustrate a commitment to transparency in communications with the public. Moving forward, the public would like developers of cellular agriculture to be transparent by providing a sense of applications under development, providing assurances that they are fully investigating the potential benefits and risks (under oversight by third parties), and providing estimated timing for the introduction of these applications. There is also a general desire and expectation that food products developed with cellular agriculture should be labeled as such.
- Choice is important to the public, and they would like to know that they will continue to have the option to choose meat from livestock. Beware that some are concerned that the development of cellular agriculture could put an end to traditionally raised meat or result in a system of haves (who can afford traditionally raised meat) and have nots (who can only afford cultured meat).
- These discussions reveal a lack of understanding of how meat is produced today and the life and conditions of most livestock. There may be potential to educate the public on current livestock conditions as a means for highlighting the benefits of cellular agriculture by comparison.

Appendix A

Overview of Discussion:

- Query group on awareness of cellular agriculture and cultured meat; participants discuss initial reactions to the terms.
- Provide written description of cellular agriculture (see Appendix B); participants discuss reactions and record whether they think the benefits of cellular agriculture outweigh the risks, the risks outweigh the benefits, or they are about equal.
- Provide handout with four potential applications of cellular agriculture (see Appendix C); participants discuss reactions and record whether they think the benefits of cellular agriculture outweigh the risks, the risks outweigh the benefits, or they are about equal.
- Show brief animated video that describes cultured meat in more detail; participants discuss reactions.
- Provide handout outlining reasons why encouraging further research in cellular agriculture is a GOOD thing (see Appendix D); participants discuss reactions and record whether they think the benefits of cellular agriculture outweigh the risks, the risks outweigh the benefits, or they are about equal.
- Provide handout outlining reasons why encouraging further research in cellular agriculture is a BAD thing (see Appendix E); participants discuss reactions and record whether they think the benefits of cellular agriculture outweigh the risks, the risks outweigh the benefits, or they are about equal.
- Provide handout with various entities that could play a part in regulating advancements in synthetic biology (see Appendix F) and ask participants to indicate their level of confidence in each one to manage potential risks related to synthetic biology. Participants discuss ratings and confidence in each entity.

Appendix B

Handout given to participants defining cellular agriculture:

WHAT IS CELLULAR AGRICULTURE?

Cellular agriculture is the production of agricultural products from cell cultures. Cellular agriculture enables the production of milk, eggs, meat, leather, fur, and other animal products from cell cultures rather than from animals. Cellular agriculture is possible by applying advances in engineering and biology to grow animal products in a lab.

Some animal products can be made without living material. For instance, milk can be made by inserting a cow's genetic code into a microbe like yeast or bacteria, which then makes milk protein.

Other animal products can be made from living or once-living cells outside the body in a process called tissue engineering. Cells from a particular animal tissue are assembled on a scaffold to grow on with food for the cells to feed on while they grow. For example, "cultured beef" can be grown from a cell culture in a lab.

Tissue engineering is a relatively new scientific pursuit, with a focus on clinical applications such as growing skin for burn victims or organs for patients requiring organ transplantation. The focus is on making a tissue-engineered organ that can function in a living person. The science behind growing tissue for an organ transplant is similar to growing muscle tissue for food, though the focus in producing food products is on nutritional value, taste, and mouthfeel.

Appendix C

Handout given to participants outlining four applications for cellular agriculture:

1. *For the first 60 years of its use as a treatment for patients with diabetes, animal insulin was collected from the ground up pancreases of pigs and cattle. Today, it is made by microbes that produce the human form of insulin. In 1978, scientists inserted the gene carrying the blueprints for human insulin into a bacteria, so the bacteria could make insulin identical to the insulin that humans make. Today, the vast majority of insulin is made this way, making the insulin supply safer, more consistent, and identical to the insulin humans produce.*
2. *Rennet is a mixture of enzymes that turns milk into curds and whey in the cheesemaking process. Traditionally, rennet is extracted from the inner lining of the fourth stomach of calves. In 1990, the FDA approved a bacteria that had been genetically engineered to produce rennet, making it the first genetically engineered product for food. Today, the majority of cheesemaking uses rennet enzymes from genetically engineered bacteria, fungi, or yeasts.*
3. *Milk is usually made by mother cows kept in a lactating state in an industrial setting. Instead, we can make the exact same milk by brewing it, using a yeast culture that consumes simple sugars to make milk proteins. The yeast was altered by inserting in it the gene carrying the blueprints for milk protein. The yeast then makes milk protein identical to the protein cows make.*
4. *In 2013, the first hamburger was made in a lab using cellular agriculture. First, stem cells, which have the power to turn into any other cell, were taken from a cow's muscle. Those stem cells were then grown into muscle fibers in the lab for six weeks to create cultured beef that was formed into a hamburger and cooked.*

Appendix D

Handout given to participants outlining reasons why encouraging further research in cellular agriculture is a GOOD thing:

- 1. It is estimated that by 2050, global demand for animal products will have increased by 70% to feed 9.5 billion people. Cellular agriculture has the potential to revolutionize the supply chain of animal products to provide affordable, safe, and sustainable food to meet the world's growing appetite for meat and other animal products.*
- 2. The use of cellular agriculture to produce cultured meat would dramatically reduce the amount of land and water required to produce meat from livestock today, and it would produce less polluting greenhouse gas emissions than are produced by cows, pigs, and poultry today.*
- 3. Because cultured meats would be produced in sterile environments, cellular agriculture products would offer a safer, purer product than their traditional counterparts. They would be free of dangerous bacteria that the Centers for Disease Control and Prevention estimates are the most common sources of fatal food-related infections caused by the contamination of conventional meat.*
- 4. The use of antibiotics in food-producing animals—to fight disease and help the animals grow faster—has been identified as a source of antibiotic-resistant bacteria that is dangerous to humans, and the FDA has reported steady increases in the use of antibiotics in livestock in recent years. Because cultured meats would be produced in sterile environments, these antibiotics would not need to be used.*
- 5. Because cellular agriculture involves producing food products in safe, sterile, controlled conditions, it can yield a more consistent supply than traditional agriculture, which is greatly affected by drought, flooding, and other weather conditions.*
- 6. Cellular agriculture provides the ability to design and tune what is being made. For instance, it could be used to make meat with fewer saturated fats and more unsaturated fats, or to make milk without lactose, or eggs without cholesterol.*
- 7. In 2007, it was estimated that more than 56 billion land animals were raised and slaughtered for food, and a large proportion of these animals were raised in very poor welfare conditions. Cellular agriculture enables the production of meats without harming animals.*
- 8. Cellular agriculture enables the production of the food products that are in demand without wasting those parts that are left unused. For example, rather than raising and fattening live chickens for slaughter, only to discard many parts of chickens that are not eaten or in demand, cellular agriculture will enable the production of just chicken meat itself without the other byproducts.*

Appendix E

Handout given to participants outlining reasons why encouraging further research in cellular agriculture is a BAD thing:

- 1. Animal products that do not come from livestock raise moral, ethical, or religious concerns.*
- 2. Animal products grown in a petri dish might behave in unpredictable and harmful ways that could harm people's health.*
- 3. The development of cellular agriculture could put traditional agriculture out of business, potentially harming our economy and leading to job losses for Americans who work on farms.*
- 4. Animal products grown in a lab will be less natural than food that comes from livestock.*
- 5. Animal products grown in a lab will not have the same taste as those that are traditionally grown.*
- 6. Animal products grown in a lab will not have the same nutritional value as those that are traditionally grown.*
- 7. Many recent studies indicate that people have developed allergies and food intolerances by creating an overly antiseptic environment for ourselves. We run the same risk with cultured meat that is made in a lab rather than through natural symbiosis.*

Appendix F

Handout given to participants listing entities that could play a part in determining and managing potential risks related to cellular agriculture:

A	<i>The US Department of Agriculture</i>
B	<i>The US Food and Drug Administration</i>
C	<i>Companies that are developing foods using cultural agriculture</i>
D	<i>University scientists and researchers involved in developing advances in cellular agriculture</i>
E	<i>Scientific bodies or panels such as the National Science Foundation</i>
F	<i>NGOs and consumer watchdog groups such as Friends of the Earth, Union of Concerned Scientists, or Consumers Union</i>
G	<i>The US Congress</i>
H	<i>Popular or renowned chefs</i>

Appendix G

Focus group participant demographics:

Non-college-educated adults

Gender	Age	Education	Employment Status	Marital Status	Religion	Ethnicity
Female	18	Some college	Employed Part Time	Single	Protestant	Hispanic
Female	26	Vocational	Employed Full Time	Single, living with partner	None	White
Female	28	Some college	Employed Full Time	Single	None	White
Male	35	Some college	Employed Full Time	Married	Catholic	White
Male	39	Vocational	Employed Full Time	Single, living with partner	Not sure	White
Male	47	Some college	Employed Full Time	Single, living with partner	None	African American
Male	47	Some college	Employed Full Time	Single	None	African American
Female	50	Some college	Employed Part Time	Married	Protestant (Born-again)	African American
Male	61	Some college	Employed Full Time	Divorced	Jewish (Orthodox)	White
Female	65	Some college	Retired	Married	Muslim	White

College-educated adults

Gender	Age	Education	Employment Status	Marital Status	Religion	Ethnicity
Female	27	4-year college	Employed Full Time	Married	None	White
Male	28	Post-graduate work/degree	Employed Full Time	Single	Protestant	White
Female	34	4-year college	Employed Full Time	Married	Christian (Born-again)	African American
Male	36	4-year college	Employed Full Time	Married	Catholic	Hispanic
Male	37	Post-graduate work/degree	Employed Full Time	Married	Catholic	White
Male	38	Post-graduate work/degree	Employed Full Time	Married	Muslim	Asian, Pacific Islander
Female	44	Some post-graduate/no degree	Employed Part Time	Divorced	Protestant	White
Male	53	4-year college	Employed Full Time	Married	Protestant (Born-again)	White
Male	56	4-year college	Employed Full Time	Married	Catholic	White
Female	63	Some post-graduate/no degree	Retired	Single	Jewish	African American