CARMA
CELLULAR AGRICULTURE MANUFACTURING HUB

Royal Agricultural University

UKRI Engineering and Physical Sciences Research Council

Cultivating Debate

Citizen Insights on a Future with Cultivated Meat

January 2026

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Executive Summary

For decades, scientists have been developing technologies and methods to grow meat from animal cells rather than raising and slaughtering animals. Meat grown through cell culturing processes is called “cultivated meat”. Cultivated meat is moving from research and development towards regulatory consideration in the UK. As this shift occurs, questions of governance, purpose, and food system implications have become more salient.

This report summarises insights from the first year of the Cellular Agriculture Manufacturing Hub (CARMA) Citizen Forum (2024-2025), an ongoing deliberative process engaging members of the public upstream of cultivated meat’s introduction in the UK. Over a year-long facilitated deliberation, citizens engaged with scientists, regulators, and other experts to explore the implications of cultivated meat for public health, the environment, equality, animal welfare, and the distribution of power within the food system. Additionally, through a series of ‘Deep Dive’ sessions on specific technical questions, the Forum has had a range of early-stage impacts on CARMA’s research agenda and the Food Standards Agency’s regulatory sandbox on cell-cultivated products.

Overall, the Forum – which consisted of 18 individuals selected to represent the diversity of the UK public – did not reach a simple position for or against cultivated meat. Instead, they have spent a year discussing their hopes and concerns and developing a set of conditions that they believe could ensure cultivated meat contributes to a fairer food future. While many were reassured by the robustness of UK food safety regulation, and the role of the Food Standards Agency (FSA), they were clear that safety alone is insufficient to secure public confidence.

The CARMA Citizen Forum’s recommendations reflect areas of broad citizen consensus about what is required for cultivated meat to earn public trust and social licence in the UK. The recommendations centre around the themes of **Public Health & Food Safety**, **Power & Transparency**, and **Equality & Affordability**.

The Forum’s Recommendations

Public Health & Food Safety: To protect public health, UK regulation should include:

1. Two-year clinical-style eating trials to measure direct health impacts.
2. Mandatory ongoing, long-term and independent product testing.
3. Strict rules on importing cultivated meat, even for products that contain traces.
4. Production licences that are only granted for a limited time frame, e.g., ten years.

Power & Transparency: To build citizen trust in the food system, UK regulators should:

1. Create a non-commercial governing body to oversee the cultivated meat industry that:
    - Provides balanced governance.
    - Collaborates internationally and steers investment to low-income countries.
    - Champions open access and antitrust law [fair competition].
    - Spots and flags loopholes through independent scrutiny.
    - Benchmarks regulatory standards.

- Sets industry norms and standards on transparency.

2. Ensure no single company can own more than one part of the supply chain or own a patent [intellectual property] for more than two years.
3. Consider factors beyond health and safety regulation – industry should also be accountable on animal ethics, environmental impacts, and industry power.

Equality & Affordability: To ensure cultivated meat contributes to a fair food system, UK policymakers should:

1. Resource a sustained analysis of how cultivated meat could impact food equality.
2. Support farmers through compensatory schemes.

The Forum's Hopes

The Forum also remained hopeful that cultivated meat would be beneficial for our food system and the planet. They hoped cultivated meat will:

- **Reduce animal suffering**. After public health, animal welfare was one of the biggest concerns of the group. In addition to hoping cultivated meat would reduce animal suffering, citizens want to see cultivated meat production processes where cells are harvested in a way that is minimally invasive, and that minimises reliance on animal products and traditional agriculture. Most members thought this would widen the market, making it appeal to vegetarians as well as meat-eaters.
- **Reduce the environmental impact of our diets.** The group understands and cares about the unsustainability of our current food system. They hope cultivated meat will help to reduce the impact of our diets on the environment.
- **Increase the resilience and security of our food system.** Given previous shocks to our food system – from famines to mad cow disease – the Forum members hope that cultivated meat could increase the resilience of our food system. They also expressed a hope that cultivated meat may provide a source of protein as the world's population grows.

Deep Dives

Throughout the year, citizens discussed a range of specific technical research questions from CARMA scientists and a question about labelling from the FSA. They gave the following guidance:

How should CARMA source animal cells for cultivated meat production?

- **In the short to medium term, the Citizen Forum recommend that CARMA focus on sourcing cells from adult animals** as long as this can be done in a way that minimises animal suffering.
- **In the longer term, they think CARMA should develop cell lines**. However, they also think that genetic engineering might make cultivated meat less likely to be accepted by the general public.
- **The group thinks CARMA should avoid using embryonic cells,** as their use raised emotive concerns and reflections on animal suffering and cruelty. They were more open to this option if they were produced by in vitro fertilisation, rather than taken from pregnant animals, however, regardless of how they are sourced, citizens felt there would be much more public pushback to this option.

What amino acid sources should CARMA focus research efforts on?

- **CARMA should explore animal by-products:** The group felt that if an animal is being slaughtered, they would prefer it all to be used, rather than parts going to waste. This was not a unanimous preference, however, as some members felt as few animal products as possible should be used.
- **Be cautious of purpose-grown crops:** The Forum raised concerns that using land to grow crops for cultivated meat production was no different to growing them for animal agriculture.
- **Keep the 'door open' to circularity and plant by-products:** The group liked the idea of circularity but had concerns that using waste from another cellular agriculture processes could 'lock-in' or amplify any contamination, citing the BSE crisis as an example of potential risks. Plant by-products were seen as a good option, although the group thought crops should be produced in a way that reduces environmental harm.

How should CARMA measure environmental impacts?

- **Environmental impact is more than GHG emissions:** Although GHG emissions ranked highly, so did other factors such as water use and eutrophication. In fact, the group felt that all the measures were important and sometimes found it hard to prioritise one over another.
- **Health impacts should be prioritised:** The Forum were most concerned about measures that directly affect human health such as toxicity.
- **Provide a comparison:** The group found it hard to weigh up the different measures and suggested that also looking at the environmental impact of traditional agriculture would make it easier to compare.
- **Add social impacts and animal welfare:** The Forum felt that it was important to weigh the environmental analysis alongside social impacts such as job creation and equal access to good food.

FSA: How should cultivated meat products be labelled?

- **Develop a clear, standardised, and mandatory front-of-pack symbol for cultivated meat**—ideally based on stakeholder co-design and public testing.
- **Ensure label prominence** comparable to allergens or health warnings.
- **Include concise wording about the product's origin**, such as: "Grown from animal cells in a lab" or "Cell-based meat, cultivated from animal tissue."
- **Use the term "cell" in the official name or category of the product** to avoid confusion and promote transparency.

Next Steps

The CARMA Citizen Forum is a multi-year process. Each year we will invite a new cohort of citizens to explore and deliberate on developments in cultivated meat and the broader area of cellular agriculture. This first chapter of the CARMA Citizen Forum represents the beginning of an ongoing process rather than a definitive statement. Future cohorts will engage with new developments and expand the focus to other areas of cellular agriculture. As these technologies continue to evolve, maintaining spaces for open, critical, and informed public deliberation remains crucial. Technical innovation alone will not determine whether cultivated meat succeeds in the UK. Its ability to contribute to a more sustainable and fairer food system will depend on how it is governed, regulated, and integrated within existing social, cultural, and political arrangements.

Introduction

Cultivated meat represents a meeting point between scientific innovation, food production, and society. Its development raises both technical challenges and broader social considerations about how food should be produced, governed, and its cultural value. Understanding these wider contexts is essential as the technology moves closer to everyday life.

The science and engineering underpinning the creation of cultivated meat is called "cellular agriculture". As an emerging field, cellular agriculture spans several academic disciplines, from cell biology, biochemistry, developmental biology, to mechanical engineering. Alongside these technical developments have emerged different questions on what happens if or when these products move from the laboratory and into our everyday lives. Increasingly, other areas such as ethics, sociology, philosophy and the social sciences are exploring the socio-cultural and political implications of cellular agriculture on both human and non-human species.

Advocates of cultivated meat present it as a response to some of the most pressing challenges facing global food systems. By growing meat directly from animal cells, rather than raising and slaughtering animals, proponents argue that the technology could reduce land and water use, cut greenhouse gas emissions, and lessen animal suffering. Additionally, this method of meat and food production could enhance food security by providing more stable sources of protein, which are arguably less vulnerable to disease and environmental disruption. For some, it represents a pathway to a more ethical and sustainable food system. A future for food that retains the familiarity and cultural appeal of meat, while addressing the harms associated with its production.[1] [2]

Yet these promises exist alongside questions that need further exploration. What are the embedded power dynamics that such technologies could introduce to the food system? Who will control these technologies, and who will benefit? Will it genuinely reduce the environmental pressures of farming, or simply shift them? What about the potential health concerns related to excess meat consumption? And what might this technology mean for farmers, for public health, and our cultural relationships with the foods we eat? The potentially wide-ranging consequences of cultivated meat make open dialogue essential. The social, cultural and political impact of such a technology requires nuanced and critical exploration. Inclusive deliberations on cultivated meat's development and deployment are also required, so that our future food systems are not just shaped by scientists, businesses and policymakers, but also by the citizens whose everyday lives and cultures may be impacted.

Over the past year, the EPSRC-funded Cellular Agriculture Manufacturing Hub (CARMA) has taken these challenges seriously. Rather than treating members of the public as *consumers* to be surveyed about future purchase preferences, CARMA has worked with them as *citizens* to explore what role cultivated meat should play in the UK's food future. Using an innovative approach to responsible

research and innovation, CARMA aims to democratise innovation and policy development within cellular agriculture, and interrogate the conditions under which cultivated meat would be given a social licence.

This report summarises the first year of an ongoing public dialogue on cellular agriculture. Led by the Royal Agricultural University, CARMA's Work Package 6 aims to engage society around this emerging field and to feed back diverse societal views to shape its development. In order to achieve this, the CARMA Citizen Forum – a socio-economically diverse and demographic representation of the UK public – are invited to engage with CARMA scientists, policy experts and private sector actors on the development and deployment of the technology. The Citizen Forum is also complemented by the CARMA Stakeholder Forum, which is made up of experts, NGO, charities and businesses whose professional interests may be impacted by the implementation of this technology.

In year one, 18 members of the public were selected to participate in the CARMA Citizen Forum. The Forum first met in September 2024 for two days of co-learning and deliberation on cultivated meat and its implications for the food system, followed by three online sessions over the subsequent year. This process will be repeated each year of the CARMA project, with a different cohort of citizens, and a progressive inclusion of underrepresented groups.

What makes this process distinctive is its closeness to real decision-making. Forum members have advised both CARMA scientists and the Food Standards Agency's (FSA) regulatory sandbox for cell-cultivated products. Their discussions have informed ongoing scientific research — from how cells are sourced to potential alternatives to commercial growth media — and have contributed to emerging regulatory debates on how such products might be labelled if they reach UK shelves.

After a year-long deliberation, most of the participants still have concerns about how cultivated meat could affect the food system. This report, co-created with Forum members, captures those perspectives. It sets out the conditions, checks, and balances they believe should be in place to help ensure cultivated meat contributes to a fairer food future.

CARMA & Cultivated Meat

Around the world, researchers and companies are exploring new ways to produce meat that could reduce pressure on the environment, improve animal welfare, and strengthen global food security.

What is Cultivated Meat?

Instead of raising and slaughtering animals, cultivated meat is produced by taking a small sample of animal cells and growing them in a nutrient-rich environment that allows them to multiply.[3] Sometimes referred to as *lab-grown meat*, the term *cultivated meat* more accurately describes meat made from animal cells grown in a nutrient broth – a cell culture medium.[4] In large-scale production, these cells would grow in bioreactors similar to the large fermenters used in brewing, not in a laboratory. The product could be grown in specific forms using an edible scaffold, could be produced as mince, or cells could be used as an ingredient and combined with plant-based ingredients to produce familiar products.

Cultivated meat for human consumption has already been approved for sale in Singapore, Israel, Australia, and some states in the USA.[2 5] In February 2025, the pet food company Meatly became the first company to sell cultivated meat in the UK.[6] The regulatory approval process for pet food is different to human food, and in the UK cultivated meat has not yet been approved for human consumption. In March 2025, the UK's Food Standards Agency (FSA) launched a regulatory sandbox programme for cell-cultivated products. Over the two-year sandbox, the FSA aims to gather evidence about cell cultivated products and how they are made, and assess health and safety requirements to inform UK regulation on the human consumption of cultivated meat.[7] A 2025 Ipsos survey of adults in Great Britain found that 32% would eat cultivated meat if it were to become available, with younger generations being more likely to eat it than older generations.[8]

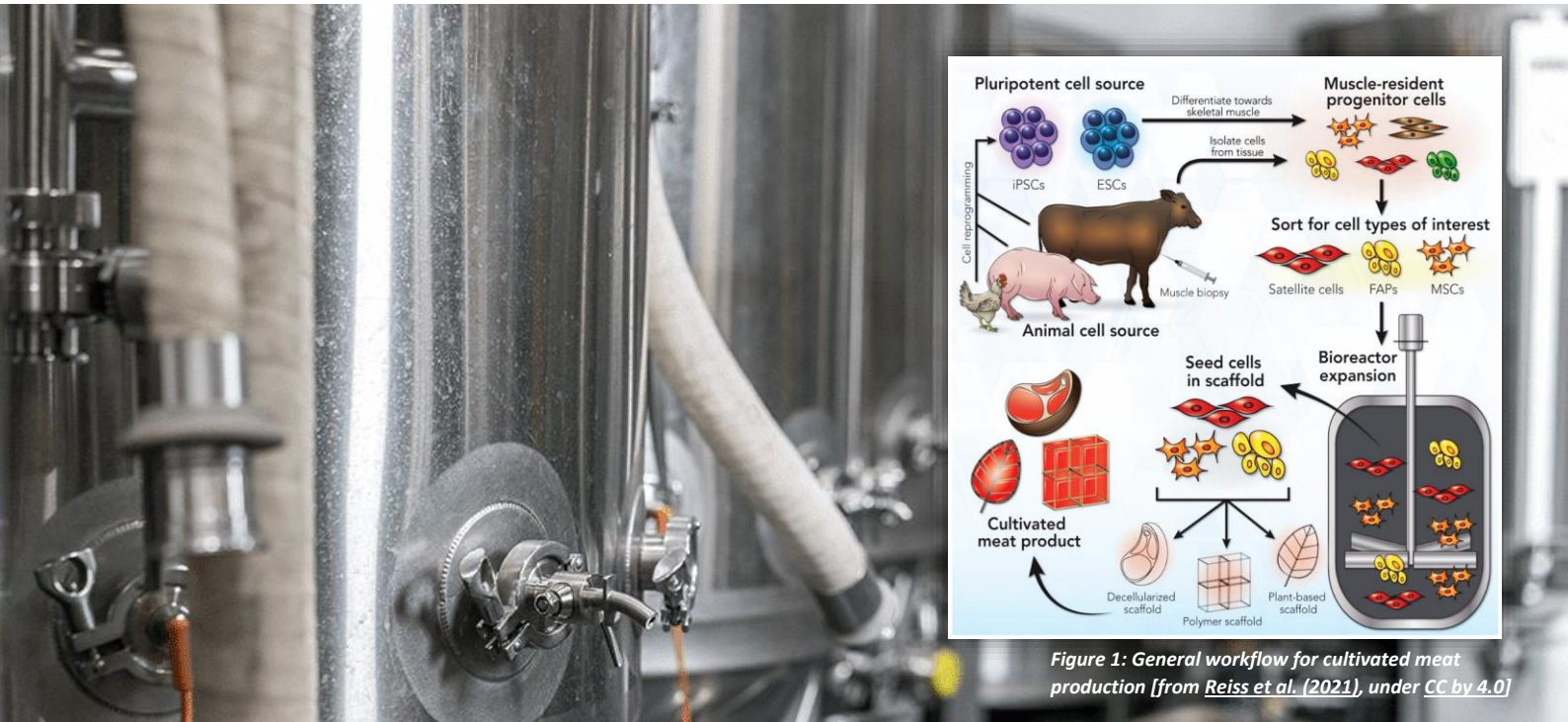


Figure 1: General workflow for cultivated meat production [from Reiss et al. (2021), under CC by 4.0]

The Cellular Agriculture Manufacturing Hub (CARMA)

Cellular agriculture is a collection of in vitro technologies and approaches seeking to produce consumables that are traditionally produced in agriculture systems. This includes the production of cellular products from plant or animal cells (such as cultivated meat), and acellular products such as milk and egg white proteins through precision fermentation using microbes.[9][10] Many of these technologies are still at the research and development stage.

CARMA is a seven-year EPSRC-funded transdisciplinary project bringing together teams of researchers, industry partners, stakeholders, and members of the public to address challenges associated with integrating novel cellular agriculture tools and technologies into food systems. CARMA's mission is the integration of transdisciplinary responsible approaches for novel cellular agriculture tools and technologies into current food systems, to deliver sustainable food manufacturing. Figure 2 displays how CARMA seeks to achieve this mission by addressing two grand challenges: (1) To design and deliver a template for an integrated UK circular cellular agriculture manufacturing value chain, and (2) To create the novel, underpinning manufacturing technologies to deliver the cellular agriculture value chain.

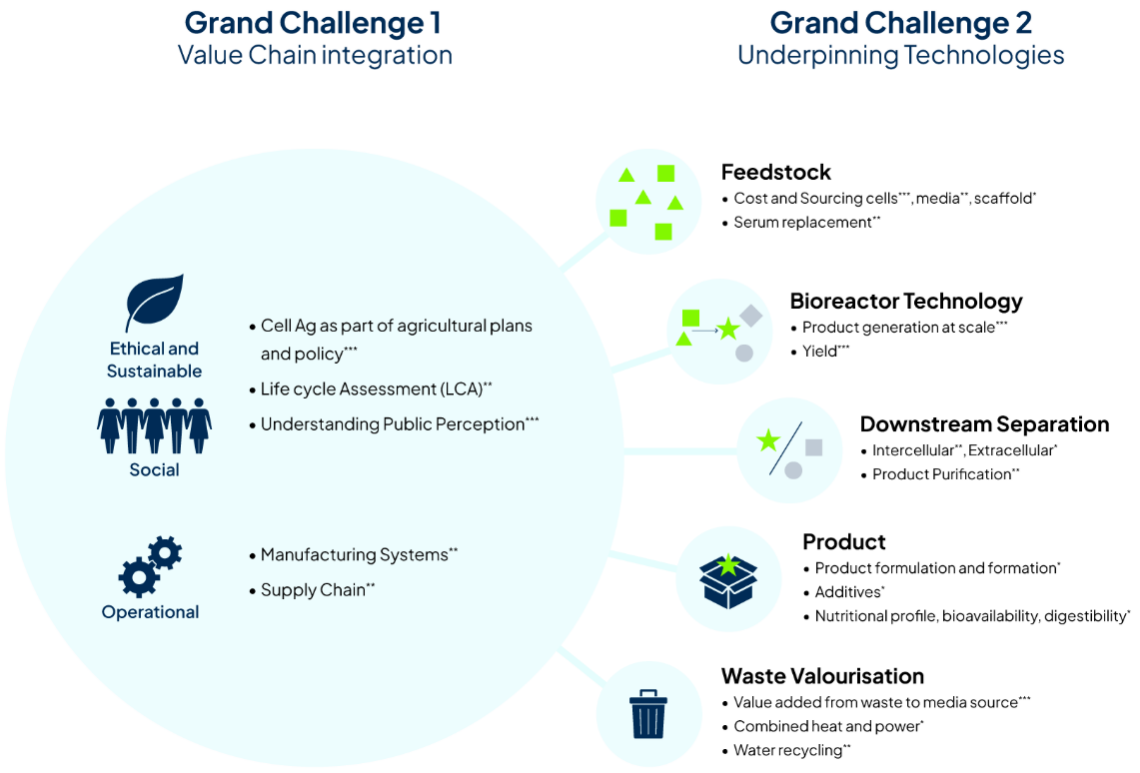


*Figure 2: CARMA's Grand Challenges. An assessment of bottlenecks to sustainable manufacturing is provided to rank the need for early-TRL (Technology Readiness Level) investment (*** most critical; ** medium; * least critical).*

These Grand Challenges are explored through collaborations across six UK-based universities – the University of Bath, University of Birmingham, Aberystwyth University, University College London, University of Bristol, and Royal Agricultural University. The CARMA project is divided into six work packages:

Work Package 1	Design of manufacturing bioreactor technologies for high yield at scale.
Work Package 2	Product purification and waste valorisation for the circular cellular agriculture bioeconomy.
Work Package 3	Create sustainable feedstocks with a robust supply chain for tissue engineering (TE) cellular agriculture.
Work Package 4	Designing a sustainable, scalable and secure future for cellular agriculture supply chains.
Work Package 5	Understanding and influencing the social issues of cellular agriculture.
Work Package 6	Engaging publics and policy.

You can find out more about the work of CARMA on the hub's website: https://carmahub.co.uk/.

CARMA labs at the University of Bath (Laurie Lapworth)

Conceptual Design

By engaging citizens and stakeholders upstream, CARMA seeks to democratise the development of cellular agriculture and explore the conditions under which these technologies would gain social licence.

Why a Citizen Forum?

A citizens' forum approach was developed because cellular agriculture raises questions of values, futures, and everyday impacts that require the inclusion of perspectives beyond technical and regulatory expertise.

The Royal Agricultural University is leading CARMA's Work Package 6: Engaging Publics and Policy. This Work Package falls under CARMA's Grand Challenge 1. Seeking to engage society around this emerging field, we use a deliberative approach to democratise the development and deployment of policy, regulation and the underpinning technologies of cellular agriculture. This work aims to bring citizens, scientists, media, policymakers, and those from potentially impacted sectors, such as farmers, into closer conversation. In this way, CARMA aims to engage openly and substantively with people's hopes and concerns and feed these into innovation and policy processes.

To meet the goals of the work package, including a multi-year deliberative process that can guide research efforts, invite scrutiny, and canvas broad opinions, an innovative approach to citizen engagement was required. This led to the establishment of the CARMA Citizen Forum.

The CARMA Citizen Forum brings together a group of individuals chosen to be indicative of the UK public. It meets regularly to critically discuss the 'big issues' surrounding cellular agriculture. Rather than framing members of the public solely as consumers, the Forum treats participants as citizens deliberating the values, assumptions, and projected futures that shape this emerging field. For example, how cultivated meat might impact their everyday lives and food experiences, how it should be regulated, and who the winners and losers may be.

In addition to these broad debates, the Forum is also tasked with discussing specific challenges and assumptions embedded in the work of CARMA scientists. These CARMA Deep Dives help shape the seven-year research programme as it progresses. In partnership with the Food Standards Agency's sandbox on cell-cultivated products, the Forum also engages in Deep Dives focused on governance. In doing so, the Forum provides a route for citizen perspectives to inform real decision-making as these technologies develop.

Design Principles

Democratic: Instead of viewing people simply as 'consumers', we engage with them as 'citizens' who have the agency and capability to inform and shape research, innovation and policy development. Citizens' contributions are understood beyond a narrow market framing to one which considers the socio-cultural and political dimensions of these technologies within food systems. Citizens bring their cultures, experiences, and values to the discussions. While we work towards reaching consensus on some topics, such as the recommendations in this report, we also embrace the complexity and range of views that these topics raise.

Annual: The CARMA Citizen Forum is not a one-off event, but an ongoing process of dialogue and learning. Forum members co-learn and engage with questions about the science, ethics, and feasibility of cellular agriculture. Over time, they become more informed and more able to engage with technical questions – but also less representative of the wider public. To counteract this transition towards lay expertise, the CARMA Citizen Forum runs in annual chapters. Each group of around 20 citizens joins for a single year before handing over to a new cohort. This approach also expands the sample size as the project develops, introducing new perspectives, and progressively including marginalised voices. To ensure that we capture project memory and build on the knowledge gained over the course of a year's engagement, a small number of citizens are invited to join the Stakeholder Forum (see below).

Iterative: Each yearly cohort meets on a quarterly basis to discuss thematic questions and to critically engage with challenges and assumptions of CARMA scientists, businesses and regulatory bodies. The programme begins with a two-day residential meeting, where citizens build trust, develop a shared understanding of the project's scope, and agree the terms of deliberation. This is followed by a series of three-hour online meetings. Over the course of the year, each cohort takes part in more than 20 hours of direct contact time, co-learning and deliberating on cellular agriculture, with discussions and insights building iteratively across the programme.

Impactful: The CARMA management team and scientists are not obliged to take on the Forum's guidance, but they are expected to provide feedback when they take a different route. In this way, the Forum has a direct channel for impact within CARMA, and increasingly beyond it too, for example, through partnership with the Food Standards Agency's regulatory sandbox on cell-cultivated products. Beyond these formal processes, the Forum also influences industry and policy representatives who interact with members over the course of the year.

Parallel: While this report focuses on the Citizen Forum, CARMA also runs a parallel Stakeholder Forum. The Citizen Forum brings together independent citizens with no professional or vested interests in cellular agriculture, while the Stakeholder Forum includes people whose work or advocacy is directly connected to the development of cellular agriculture. These include farmers, environmental NGOs, funders, academics, animal welfare groups, campaigners, industry bodies and health professionals. The two groups meet on similar topics at similar times, but play distinct roles. Citizens offer an open public perspective, while stakeholders bring sector-specific critique and insight. After a year of taking part in the Citizen Forum, some citizens are invited to join other stakeholders who interact with the project through our Stakeholder Forum.

This report summarises the discussions and guidance from the first chapter of the CARMA Citizen Forum which ran from 2024-2025. This chapter focused exclusively on cultivated meat; future chapters will also explore other areas of cellular agriculture.

Limitations

A citizens' forum approach was developed because it is well suited to guiding research in a long-term, iterative way. While this represents an innovative approach to public engagement within cellular agriculture, it also comes with a number of limitations:

Indicative, not representative: Despite efforts to achieve demographic and socioeconomic diversity, the CARMA Citizen Forum necessarily represents a relatively small pool of perspectives. As with most deliberative exercises, the views captured are indicative rather than statistically representative. What really matters is the depth of reasoning that produced them. While we acknowledge the limitations associated with a small sample size and the general challenges of sampling within citizen research, smaller groups enable open and deep discussions, and trust building over the year-long engagement. The limitation of small sample sizes will be mitigated by recruiting a new cohort of citizens each year, potentially engaging over 100 citizens over the duration of the project.

Independent, not stakeholder: Care has been taken to separate the Citizen Forum from the Stakeholder Forum, which represents those with professional or special interests in the field. This separation provides space for discussions away from vested interests, and means our citizen cohort does not include organised or established advocacy voices either for or against cultivated meat. However, a wide range of perspectives including critical voices are presented to citizens through external speakers.

Specific knowledge environment: Forum members are exposed to a curated knowledge environment – shaped by both CARMA and external experts – which supports informed discussion but inevitably influences how they come to understand cultivated meat and its implications.

Time and depth: Like any deliberative process, time constraints limit how deeply participants can explore the full range of scientific and societal issues. Additional contact time throughout the year would increase both breadth and depth of deliberations.

Translation into impact: While the Forum's guidance feeds into CARMA's research and regulatory discussions, its influence depends on how these insights are taken up and acted upon.

Such features are intrinsic to efforts to bring citizens into complex, evolving areas of science and policy. They should be kept in mind when interpreting the findings.

Food Systems Thinking

The food system is characterised by social and economic change, including market intensification, growth in processing and packaging, corporate concentration in retail and distribution, and the rising influence of urban consumers. Food practices developed through technoscience, like cellular agriculture, can alter and disrupt food systems.[11] By embedding public deliberations in food systems thinking, our approach not only examines *how* cultivated meat could be produced but *why* and *for whom*. It encourages broader thinking about the hopes, concerns and implications of cultivated meat within the broader claims of food system transformation and a just transition to equitable and sustainable food futures.

We apply food systems thinking as both an analytical and practical framework for exploring how cellular agriculture might fit within wider social, economic, and environmental contexts. [12] The approach views cultivated meat not as an isolated technological fix but as one component in a complex network of actors, and activities such as production, processing, distribution, and consumption. This allows us to understand the multiple interactions of actors, and activities of a broadly defined food system with environmental, geopolitical, and technological change, and evaluate the major societal outcomes e.g., considerations about farming practices, food security, ecosystem services and social welfare.[13] [14] [15] In practice, citizens are invited to examine how cellular agriculture interacts with food security, environmental sustainability, and social, cultural and political arrangements within the food system (see Figure 3).

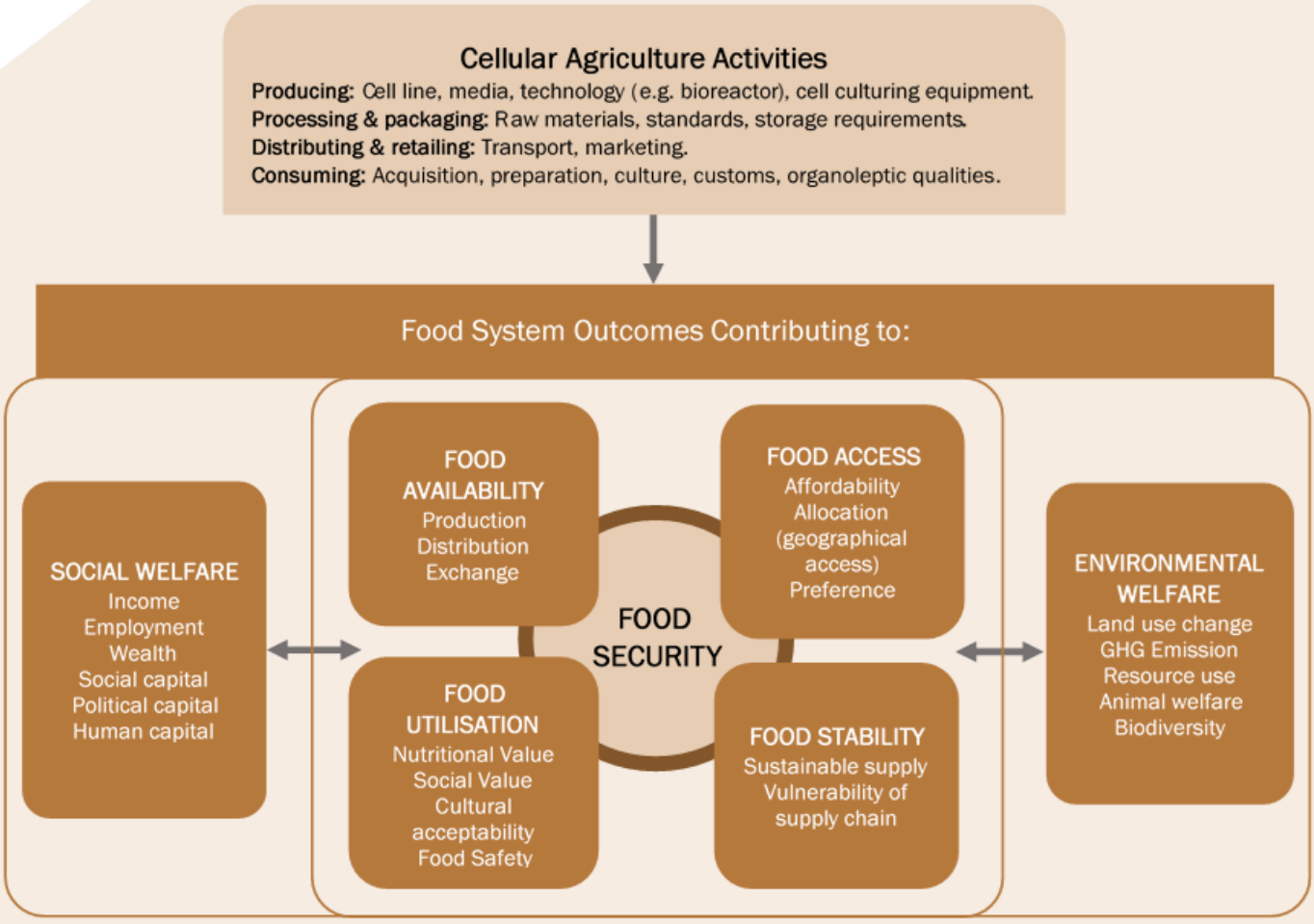


Figure 3 How cellular agriculture activities could impact the food system. [Adapted from Ericksen (2012)]

Programme

Since the Forum launched in September 2024, developments in the UK, such as the launch of Meatly's dog treats containing cultivated meat, the Food Standards Agency's sandbox on cell-cultivated products, and the Bezos Centre for Sustainable Protein, have solidified what had felt to many like a hypothetical debate.[6 16 17]

During this time, participants of the first chapter of the CARMA Citizen Forum built their knowledge of the cultivated meat industry through engaging in deliberations with expert speakers and other co-learning activities. The role of these expert speakers at Forum meetings is to provide sector specific insights. The focus is on informing rather than influencing or selling the 'product' as in market research. Every effort has been taken to invite people with wide-ranging opinions to give the participants a realistic view of the issues surrounding cellular agriculture.

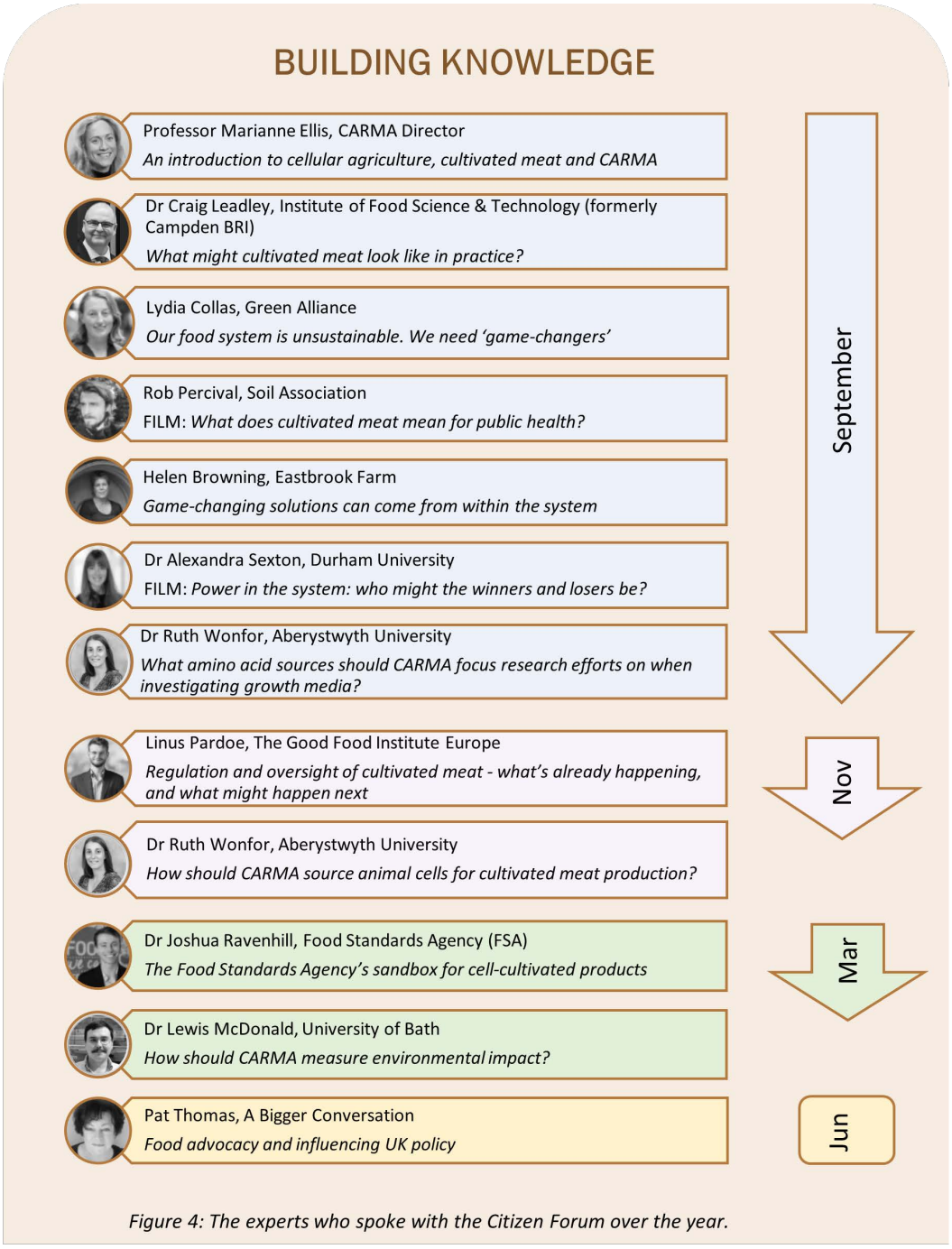


Figure 4: The experts who spoke with the Citizen Forum over the year.

The CARMA Citizen Forum had a 'front-row seat' as the UK made decisions about whether cultivated meat will be part of our diets. The Forum's conversations echoed this shift, moving from the theoretical in September 2024 to what needs to be done in practice in the final meeting in June 2025. Table 1 is a summary of the deliberation schedule of the Forum from September 2024 – June 2025.

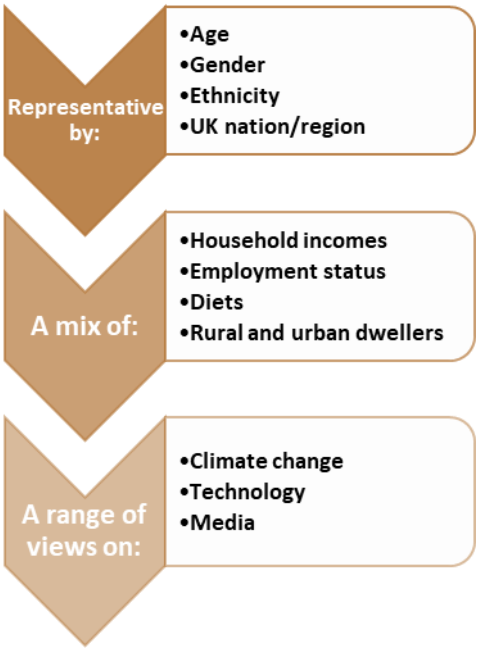
Table 1: The 2024/2025 CARMA Citizen Forum Programme, including key theme for each session, key discussions and details of deep dives

	September	November	March	June
Theme	In Theory: What is cultivated meat and what could it mean?	Globally: What is happening around the world with regulation, research and funding?	In the UK: How is the FSA assessing cultivated meat?	In Reality: How do we want policymakers to act?
Location	In-person	Online	Online	Online
Key Discussion	What role should cultivated meat play in our future food system? What are the Forum's 'conditions of acceptability'?	Are the Forum's 'conditions of acceptability' being met globally?	Will the FSA's sandbox address the Forum's concerns about cultivated meat?	What checks and balances should policymakers put in place to create a fair food system?
Deep Dive	WP3: What amino acid sources should CARMA focus research efforts on when investigating growth media?	WP1/2/3: How should CARMA source animal cells for cultivated meat production?	WP4: How should CARMA measure environmental impact?	WP6: How should the CARMA Citizen Forum present its opinions? & Food Standards Agency: How should cultivated meat products be labelled?

Recruitment

The members of the 2024 - 2025 Forum were recruited through a market research agency. In year one, from a database of over 30,000 people, 7,300 invitations were sent, with 581 responses to our invitations. 21 people were selected to join the Forum based on predetermined selection criteria, including demographics and socioeconomic status, geographical location and perspectives on topics such as diet preferences, climate change, politics and technology (Figure 5). Where certain important groups made up less than 5% of the UK population, we included them in order to have a representative participant, e.g., Northern Irish (<3%) and vegan (<4%). These minority groups, relative to the UK population, will be progressively added as the project develops. Of the 21 people selected to take part, 18 participants joined the Citizens Forum.

Figure 5: Demographic and attitude sampling criteria



The Forum's Recommendations

Over the course of a year, the CARMA Citizen Forum deliberated on the role of cultivated meat in our food future. Participants heard about the deep-seated issues in our current food system, the hopes of the cultivated meat industry, and how the UK and other countries plan to ensure cultivated meat's safety.

How can cultivated meat have a positive impact on our food system?

There are still too many unanswered questions for the Forum to say definitively whether they think cultivated meat will have a positive or negative impact on our food system. Instead, they consistently raised their concerns and spent time considering how these should be mitigated. As well as thinking about the risks, citizens also thought about how cultivated meat could most benefit the food system.

Over the past year, the group's concerns about cultivated meat held fairly steady. Conversations from the first meeting were closely mirrored in later discussions about what should be included in this report. The group were asked to consider what would help address their concerns, and reached broad consensus in developing the following recommendations.

Citizen Forum launch weekend at the Royal Agricultural University, Sep 2024

Public Health and Food Safety

Human health consistently topped the group's concerns about cultivated meat. For example, how members of the public may react to allergens, or the long-term health implications of eating cultivated meat. From a food system perspective (see Figure 3), this relates to people's ability to process the foods that are available to them, or if these foods impact their health. This represents the food utilisation pillar of food security.[13] The rise in non-communicable diseases such as obesity and heart disease, and their links to meat consumption and ultra-processed foods was an important component of these deliberations. Having heard from the Food Standards Agency, citizens were mostly reassured by the rigour of processes here in the UK and that products will be safe to consume. Instead, their concerns went beyond the immediate safety of a product and related to the following scenarios:

- Long-term health impacts which may come to light when it is too late.
- Contributions to worsening health trends such as obesity and reliance on ultra-processed foods (UPFs).
- The dangers of batch contamination and imported foods from areas with less stringent regulation.
- That certain groups, for example those who are immunosuppressed, may respond differently to the general population.

To protect public health, UK regulation should include:

1. Two-year clinical-style eating trials to measure direct health impacts.
2. Mandatory ongoing, long-term and independent product testing.
3. Strict rules on importing cultivated meat, even for products that contain traces.
4. Production licences that are only granted for a limited time frame, e.g., ten years.

"I'm very pro having eating trials. I think it's the only way that we can really test it in the real world. But my one concern is that I'd really want them to be longitudinal studies. You know, your diet doesn't change in a week, and we don't know what impact [cultivated meat] could have over a year, or when people get, you know, older in life, if it impacts their health."

- CARMA Citizen

"The regulation might be focused on health and safety aspects, but the issues people care about and that matter are all lots of other things as well."

- CARMA Citizen

Power and Transparency

Trust was a consistent theme of the deliberations. The group largely felt the technology is being developed 'in good faith', but the involvement of corporate interests may replicate or reinforce existing inequalities embedded in current food systems. Concerns around the involvement of corporate interests contributed to a perception of distrust among participants and the feeling that decisions will not be made for the common good but for profit. Concerns around power and transparency were expressed in the following ways:

- The companies that produce cultivated meat could have too much control over the food system, particularly by undercutting and replacing traditional meat production, so that the system becomes reliant on cultivated meat.
- Income currently going to smaller producers and into local economies will be consolidated into a few, multi-national corporations, with profits going offshore. This could impact jobs and reduce people's ability to afford food. This would negatively impact food security within disadvantaged households.
- The cultivated meat industry will not be transparent about their production methods, ingredients, or finances.
- Government will not be transparent about their interests in cultivated meat.

To build public trust in the food system, UK regulators should:

1. Create a non-commercial governing body to oversee the cultivated meat industry that:
    - Provides balanced governance.
    - Collaborates internationally and steers investment to low-income countries.
    - Champions open access and antitrust law [fair competition].
    - Spots and flags loopholes through independent scrutiny.
    - Benchmarks regulatory standards.
    - Sets industry norms and standards on transparency.
2. Ensure no single company can own more than one part of the supply chain or own a patent [intellectual property] for more than two years.
3. Consider factors beyond health and safety regulation – industry should also be accountable on animal ethics, environmental impacts, and industry power.

"We don't want relationships where places have become dependent on cultivated meat producers and they're locked into paying certain amounts of money that they maybe could better spend on other ways of being food secure."

- CARMA Citizen

Equality and Affordability

One of the biggest unanswered questions about cultivated meat is where it will enter the food system. Will it be a premium 'meat alternative' product, or will it replace the cheapest processed meats, such as the chicken nugget? The group's concerns around equality largely hinged on this question. Food access is people's ability to have physical and economic access to the type, quality and quantity of food they require for an active life. While cultivated meat could increase food availability, the Citizen Forum were concerned that:

- There may be a 'two-tier' food system where only some groups can afford cultivated meat, or that some groups may only able to afford cultivated meat and not traditional meat.
- It may displace other potentially healthier sources of protein, such as pulses, and disrupt food culture and tradition.
- It could result in job losses in farming and impact rural economies in the UK.
- It may deepen inequality between the Global North and South.

To ensure cultivated meat contributes to a fair food system, UK policymakers should:

1. Resource a sustained analysis of how cultivated meat could impact food equality.
2. Support farmers through compensatory schemes.

"For me [equality of access] takes, you know, large multinational organisations to have some sort of control and regulation … and not entirely just left to market forces where the developed world has already got 51 out of the 52 cards."

- CARMA Citizen

The Forum's Hopes

These big unanswered questions, highlighted in the previous sections, demonstrate the Forum's concerns about how cultivated meat might impact the food system and what could be done to mitigate these risks. However, the Forum also remained hopeful that cultivated meat would be beneficial for our food system and the planet.

The Forum hopes cultivated meat will:

- **Reduce animal suffering**. After public health, animal welfare was one of the biggest concerns of the group. In addition to hoping cultivated meat would reduce animal suffering, citizens want to see cultivated meat production processes where cells are harvested in a way that is minimally invasive, and that minimises reliance on animal products and traditional agriculture. Most members thought this would widen the market, making it appeal to vegetarians as well as meat-eaters.

- **Reduce the environmental impact of our diets.** The group understands and cares about the unsustainability of our current food system. They hope cultivated meat will help to reduce the impact of our diets on the environment.

- **Increase the resilience and security of our food system.** Given previous shocks to our food system – from famines to mad cow disease – the Forum members hope that cultivated meat could increase the resilience of our food system. They also expressed a hope that cultivated meat may provide a source of protein as the world's population grows.

"Please continue developing cultured meat and cellular agriculture! Despite some doubts, it can be a useful addition to the food world and can help food security if produced following strict guidelines."

- CARMA Citizen

"The most important thing for me would be the environmental issues and hopefully the environmental benefits in the medium term. That would be the most significant thing for me. And yes, I don't like animal cruelty…
The critical thing for me that I've learned during this process is it is pretty much a necessity that there will be an exhaustion of resources, maybe not in my lifetime, but at some stage it becomes necessary to start cultivating things to feed the world's population."

- CARMA Citizen

Impacts

Across the year, CARMA scientists shared three challenges from their research with the Citizen Forum. The FSA also shared a challenge as part of its regulatory sandbox. In this section we outline the nature of these Deep Dive challenges, the feedback from the citizens, and the early-stage impacts this feedback had on CARMA's research agenda and the FSA's regulatory sandbox.

How should CARMA source animal cells for cultivated meat production?

CARMA's Work Package 3 is investigating cell sources to determine cells that are sustainably sourced and efficient at producing cultivated meat. As there are a range of cell types that can be used, they wanted to better understand citizens' views and feelings about commonly used cell types and weigh their opinions alongside the technical qualities of the cells. In this way, CARMA researchers could feel more assured of the direction of their work, and take steps towards future cultivated meat products having social licence.

The Citizen Forum were presented with an overview of four common cell sources: from **adult animals**, from **embryos**, using **adult cells genetically reprogrammed to be more similar to embryonic cells**, and **cell lines created using genetic engineering**. Citizens discussed the options in small groups and suggested the following guidance:

- **In the short to medium term, the Citizen Forum recommend that CARMA focus on sourcing cells from adult animals** as long as this can be done in a way that minimises animal suffering. After safety, animal welfare was the most important consideration for the group.
- **In the longer term, they think CARMA should develop cell lines**. However, they also think that genetic engineering might make cultivated meat less likely to be accepted by the general public.
- **The group thinks CARMA should avoid using embryonic cells,** as their use raised emotive concerns and reflections on animal suffering and cruelty. They were more open to this option if they were produced by in vitro fertilisation, rather than taken from pregnant animals, however, regardless of how they are sourced, citizens felt there would be much more public pushback to this option.

Impact: Work Package 3 are initially working on bovine adult cell lines sourced from animals going through the slaughter process, therefore not incurring any additional slaughter or suffering. However, following the guidance from the Citizen Forum, they will also look to develop their work to incorporate other cell types as well as employing genetic engineering to further develop their research to produce more robust cell lines in the longer term.

Prof Marianne Ellis, CARMA director, also held a meeting with all the CARMA researchers who are using cells in their research as the CARMA management team were keen to find a standard option that could be used across all the relevant work, to be able to directly compare and more easily translate findings across groups. Everyone was invited to prioritise the cell qualities most important for their work, and feedback from the Forums was weighed along with these other factors. The team decided that CARMA researchers will seek an adult bovine cell line if appropriate for their work, however since there is no known suitable cell line available, they will utilise other cell lines in the meantime albeit keeping the short-, medium- and longer-term recommendations from the Citizen forum in mind.

Dr Ruth Wonfor

CARMA Work Package 3 Lead

1872 PRIFYSGOL ABERYSTWYTH UNIVERSITY

"The perceptions from the citizens on the cell sources for cultivated meat were very insightful for our research. We had not thought that genetically engineered cell lines would receive such support and so this understanding, along with current regulatory developments has really opened up this avenue of research for us. We can start building on our defined adult stem cells to now look at future potential for genetic engineering to develop a more robust cell line that can be used to scale production."

Professor Marianne Ellis

Director of CARMA

UNIVERSITY OF BATH

"It is fantastic that the Citizen Forum has been able to contribute in this way; doing so early will allow us to maximise their steer on our research efforts. The discussions have been engaging and productive and such participatory research will continue to be central to our thinking and planning going forward."

What amino acid sources should CARMA focus research efforts on?

One of the biggest barriers to scaling up cultivated meat production is the cost of 'growth media' – the feedstock containing all the ingredients the cells need to proliferate. Amino acids are a particularly expensive ingredient in this feedstock as currently they are mostly sourced at pharmaceutical grade. Dr Ruth Wonfor leads CARMA's Work Package 3, focusing on the cultivated meat supply chain and creating sustainable feedstocks. Part of her role is investigating alternative amino acid sources. As well as considering the practical and technical potential of these alternatives, Ruth is also interested in how they could be perceived by members of the public.

The Forum was presented with four alternative sources for amino acids: **plant by-products** from farming such as rapeseed meal, **animal by-products** such as bovine blood and hoof and horn meal, **purpose-grown crops**, and **re-cycling by-products** from within cellular agriculture production. After discussing the options in small groups, they provided the following guidance:

- **CARMA should explore animal by-products:** The group felt that if an animal is being slaughtered, they would prefer it all to be used, rather than parts going to waste. This was not a unanimous preference, however, as some members felt as few animal products as possible should be used.
- **Be cautious of purpose-grown crops:** The Forum raised concerns that using land to grow crops for cultivated meat production was no different to growing them for animal agriculture.
- **Keep the 'door open' to circularity and plant by-products:** The group liked the idea of circularity but had concerns that using waste from another cellular agriculture process could 'lock-in' or amplify any contamination, citing the BSE crisis as an example of potential risks. Plant by-products were seen as a good option, although the group thought crops should be produced in a way that reduces environmental harm.

Ruth's work on this subject is at a very early stage, however as a result of the feedback she plans to **explore animal by-products.** The cultivated meat industry tends to position itself as working towards being animal-free. This would mean a shift in a different direction but may appeal to ethical meat eaters. Since speaking with the Forum, Ruth has decided to invest more research time into this option.

Dr Ruth Wonfor

CARMA Work Package 3 Lead

PRIFYSGOL ABERYSTWYTH UNIVERSITY

"We are pursuing our work on plant by-products from current agricultural systems. Following the Forum, we are also looking at potential avenues for sourcing safe to use animal by-products, whilst keeping our sustainability focus for the hub at the centre of our research.

The feedback around the circularity of using waste from other cellular agriculture systems was quite surprising to us and highlighted a need for better communication from us and more insights provided into the way this would work and safety considerations we will make – this will be brought back to the Forum in the future so that we have some circularity in this participatory research as the research develops within CARMA, therefore keeping the citizens involved in the research progress, as well as research development."

How should CARMA measure environmental impacts?

For many, the reason for developing cultivated meat is to find an environmentally sound alternative to animal agriculture. The main metric for this tends to be greenhouse gas (GHG) emissions, but there are many other ways to measure environmental impact. CARMA's role in this debate is to examine a broad set of metrics to quantify the potential environmental profile of cellular agriculture processes.

Dr Lewis McDonald is leading a life-cycle analysis (LCA) as part of CARMA's Work Package 4: designing a sustainable, scalable, and secure future for cellular agriculture supply chains. Lewis is measuring the environmental impact of cultivated meat as an alternative to red meats, and has a wide range of metrics which he can use to do so. Lewis asked the Citizen Forum which of these metrics resonated most with them in order to prioritise what matters to people in his research and how he reports the findings.

The Forum were asked to consider a long list of measures by which CARMA could assess the environmental impact of cultivated meat. Citizens were then asked which mattered most to them individually, and gave the following collective feedback:

- **Environmental impact is more than GHG emissions:** Although GHG emissions ranked highly, so did other factors such as water use and eutrophication. In fact, the group felt that all the measures were important and sometimes found it hard to prioritise one over another.

- **Health impacts should be prioritised:** The Forum were most concerned about measures that directly affect human health such as toxicity.

- **Provide a comparison:** The group found it hard to weigh up the different measures and suggested that also looking at the environmental impact of traditional agriculture would make it easier to compare.

- **Add social impacts and animal welfare:** The Forum felt that it was important to weigh the environmental analysis alongside social impacts such as job creation and equal access to good food.

Dr Lewis McDonald
CARMA Work Package 4
UNIVERSITY OF BATH

"After taking part in the Citizen Forum, it is now clear to us in Work Package 4 which impacts are priorities for citizen stakeholders. In addition to using the broad set of environmental impacts that were discussed with the group, we are also working towards using appropriate methods to assess social and animal welfare impacts."

FSA: How should cultivated meat products be labelled?

Labelling cultivated meat is complex. There are statutory requirements, but also industry norms and consumer expectations. Decisions need to be made on what it should be called, what goes on the ingredient list, and on the packaging. Getting it right will help cultivated meat businesses communicate about their products while building customer trust, but balancing competing needs is difficult.

The FSA's sandbox on cell-cultivated products hosts regular workshops with cultivated meat businesses, academics, and representative bodies. CARMA is a member of the sandbox and representatives attend these meetings. For a workshop on labelling, the FSA asked the CARMA Citizen Forum for their views, which were fed in alongside the views of cultivated meat producers and researchers. The Forum suggested the FSA should:

- **Develop a clear, standardised, and mandatory front-of-pack symbol for cultivated meat**—ideally based on stakeholder co-design and public testing.
- **Ensure label prominence** comparable to allergens or health warnings.
- **Include concise wording about the product's origin**, such as: "Grown from animal cells in a lab" or "Cell-based meat, cultivated from animal tissue."
- **Use the term "cell" in the official name or category of the product** to avoid confusion and promote transparency.

Dr Joshua Ravenhill
Head of the Cell-Cultivated Product Sandbox Programme

Food Standards Agency
food.gov.uk

"The FSA is in the process of developing its policy approach towards labelling, and the insights from the Citizen Forum on this subject have been very helpful in providing us with a deeper understanding of the issues that will be important for consumers. In particular, the forums have indicated how labelling can affect the potential understanding of these new foods, and the type of labelling strategies that should be considered.

We will continue to feed the information obtained from these forums back to industry and to relevant government departments as we collaboratively work to finalise our policy approach in this area and provide guidance for industry on the labelling of these products. The information from this forum, as well as others, will help us design a position that ensures consumers are safe and can make informed decisions."

Conclusion

This report documents a year of sustained public deliberation at a point when cultivated meat is moving from a hypothetical future towards regulatory reality in the UK. The 18 members of the CARMA Citizen Forum have had front-row seats to these developments.

The Forum did not reach a simple position for or against cultivated meat. Instead, over the year citizens developed and reached broad consensus on a set of conditions – the Forum's recommendations set out in this report – that they believe should be implemented to ensure cultivated meat contributes to a fairer food future. While many were reassured by the robustness of UK food safety regulation and the role of the Food Standards Agency, they were clear that safety alone is not sufficient to secure public confidence and acceptability. Concerns about long-term public health, corporate power, transparency, environmental impacts, and social and global inequalities remained central throughout the year. These issues were seen as fundamental to how cultivated meat would be judged if it is to be integrated as part of the food system.

The value of the Citizen Forum lies not in producing a representative snapshot of public opinion, but in the depth of deliberation generated through sustained engagement. Through more than 20 hours of deliberation over the course of a year, participants were able to interrogate expert claims, reflect on trade-offs, and refine their views as their understanding developed. This process generated insights that are difficult to capture through conventional surveys or consultations, particularly regarding trust, legitimacy, and social licence. Importantly, these insights have already informed aspects of CARMA's research agenda and developing regulatory discussions, reaffirming the importance of deliberative upstream engagement.

> *"I think spaces like this are absolutely essential for progress and making sure we are being transparent and ethical in future decisions."*
>
> - CARMA Citizen

For policymakers and regulators, the Forum's guidance highlights the limits of a narrowly technical approach to governance. Decisions about cultivated meat will shape not only what products are approved for sale, but also how power, risk, and benefit are distributed across the food system. Addressing public concerns around transparency, power, and equity will be essential if cultivated meat is to be developed in ways that are socially as well as technically viable.

This first chapter of the CARMA Citizen Forum represents the beginning of an ongoing process rather than a definitive statement. Future cohorts will engage with new developments and expand the focus to other areas of cellular agriculture. As these technologies continue to evolve, maintaining spaces for open, critical, and informed public deliberation remains crucial. Technical innovation alone will not determine whether cultivated meat succeeds in the UK. Its ability to contribute to a more sustainable and fairer food future will depend on how it is governed, regulated, and integrated within existing social, cultural, and political arrangements.

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Images
Cultivated meat workflow from **Reiss et al. (2021)**, under **CC by 4.0** (edits: brightened and shadow). CARMA Hub lab photos by Laurie Lapworth. Other images sourced from Unsplash.com under free use licence: Ivy Farm Technologies (cultivated meatball cover image) and Leon Ephraïm (cows).

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