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POSTnote 740

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Cultivated meat

Overview

- Cultivated meat is produced by growing cells from animals in vessels under controlled conditions. As of April 2025, available products are 'hybrid' consisting of plant protein and cultivated meat cells.
- Cultivated meat production could reduce the number of animals slaughtered for food. This could reduce antimicrobial use, land use and emissions of some greenhouse gases, such as methane. The Climate Change Committee has advised that UK meat consumption should reduce to meet net zero targets.
- UK research groups and cultivated meat companies are globally recognised, and in 2025 the UK became the first European country to sell cultivated meat in pet food.
- Technology, production costs and capacity, a lack of infrastructure, public acceptance and regulation are currently barriers to the widespread commercial availability of cultivated meat. The viability of the cultivated meat sector is still unclear.
- The social, economic and environmental implications of cultivated meat are uncertain, as the industry has not scaled. Few studies into potential challenges and opportunities for the rural economy exist. Examples of possible implications include job losses, loss of income, opportunities to supply the cultivated meat industry with ingredients and on-farm production.

Background

Meat is a traditional component of UK diets and is a source of protein, fat and nutrients. Livestock farming is part of the UK's rural economy, accounting for 62% (£19.2 billion) of the value of UK agricultural production in 2023.[1]

Concerns over climate change, habitat destruction, pollution, antimicrobial resistance, and animal welfare have increased interest in improving the sustainability of meat production and providing alternatives to conventional meat (PN 701). Food systems are complex, and strategies to change them to address these concerns include reducing the environmental impact of existing production systems and encouraging dietary change.[a] [2]

One strategy is producing food for human consumption made from animal cells grown in vessels called bioreactors.[3] This emerging technology is called cultivated meat.[4]

Food can be an emotive topic and discussions surrounding cultivated meat can be politically sensitive.[5]

Cultivated meat products are approved for human consumption in some jurisdictions, and banned in others.[6]

In July 2024, the UK approved a pet food product containing 4% cultivated chicken.[7] A limited launch took place in February 2025, making the UK the first European country to sell cultivated meat.[b]

Environmental and societal implications of cultivated meat are speculative, as it is unclear if manufacturing will occur at scale.

What is cultivated meat?

Cultivated meat is sometimes referred to as 'lab-grown' or 'cultured' meat (table 1).[c] [11]

Researchers in cultivated meat, both in academia and industry, are exploring potential production methods for a diverse range of products (figure 1). Cells sourced from animals, including terrestrial livestock and fish, are grown to form products with different structures. These include mince-like products, cultivated animal fat, steak and foie gras.[12]

[a] Examples include feeding livestock more environmentally sustainable crops, developing foods that mimic meat from plants and fungi, and encouraging the consumption of legumes.

[b] This POSTnote focuses on cultivated meat for human consumption.

[c] Terms used to describe cultivated meat have changed over time due to studies into public understanding and acceptability. Discussions regarding the adjective used and the use of the term 'meat' are ongoing.[8] Other terms used include 'synthetic meat' [9] and 'clean meat'.[10]

As of April 2025, products available for human consumption are 'hybrid', consisting of plant proteins combined with cultivated meat cells.[13]

Table 1 Definitions

Term	Definition
Alternative proteins	Protein-rich foods that do not come from conventional animal sources. They are made from plants, fungi, insects, cultivated meat, or a combination of these ingredients.
Cell-cultivated products	Foods produced using animal or plant cells, including cells from meat, seafood, fat, offal, or eggs, without traditional agricultural practices and slaughter. Others include cultivated animal fat and milk components made by animal cells. The UK Food Standards Agency (FSA) refers to cultivated meat as a 'cell-cultivated product' of animal origin.
Cell culture	The process of growing cells outside an organism. Cultivated meat is an example of cell culture. Cells grow in a liquid culture medium, therefore cell culture volume is described in litres.
Cell culture medium	A nutrient-rich liquid containing proteins, growth factors, sugars, amino acids, vitamins and minerals to support cell growth. Different cell types require different media. Growth factors are molecules that affect the growth and development of cells.[14]
Bioreactor	A vessel designed to facilitate cell growth. The temperature, oxygen concentration and acidity inside the bioreactor are carefully controlled.
Stem cell	A cell with the ability to form different cell types, including muscle and fat cells.[15]
Tissue	Groups of similar cells performing a specific function.[16]
Scaffolds	Structures that provide physical support for cells, allowing them to grow and mature into structured cultivated meat products that mimic muscle tissue.

Source: All definitions not referenced in-text have been taken from Short et al (2022)[17]

Climate policy relevance

The Climate Change Committee's advice to the government in the 2025 Seventh Carbon Budget outlines a path to net zero by 2050.[d] [18] This requires, compared with 2019:

- average meat consumption to decline by 25% by 2040 and 35% by 2050
- red meat consumption to decline by 40% by 2050[e]

To achieve these targets, the Budget suggests a shift to 'alternative proteins' in diets.[18] There is limited evidence to show that increasing the consumption of alternative proteins, including cultivated meat, will reduce conventional meat consumption.[19]

The 2021 National Food Strategy, a government-commissioned independent review, proposed an increase in the consumption of 'alternative proteins', including cultivated meat, to decarbonise the food system.[20]

Innovation policy relevance

The 2025 House of Lords Science and Technology Committee report on engineering biology identified cultivated meat research as an example of UK innovation.[21] The 2023 National Vision for Engineering Biology, published by the Department for Science, Innovation and Technology (DSIT), also highlighted UK innovation in the cultivated meat supply chain.[22]

The Food Standards Agency (FSA), in collaboration with Food Standards Scotland (FSS), was awarded £1.6 million from DSIT in October 2024 to run a two-year 'sandbox'[f] programme for cell-cultivated products (see UK regulation of cultivated meat).[23]

The FSA has stated that safety assessments of two products will be completed during the programme.[24]

Cultivated meat manufacturing

Meat has a complex three-dimensional structure composed of different cells and tissues, such as muscle and fat.[4] Cells grow, divide and mature into different cell types. This requires nutrients, such as sugar, and biochemical signals, such as growth factors.

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[d] The UK is legally required to meet net zero emissions by 2050 under the Climate Change Act of 2008.

[e] Red meat is considered separately due to higher greenhouse gas (GHG) emissions compared with other types of meat.

[f] DSIT defines a sandbox as "An environment where firms can test new innovations under the supervision of a regulator. Regulations are often relaxed, or rules are adapted within the sandbox to allow for more innovative or creative working". This sandbox aims to engage stakeholders including companies, researchers, trade bodies, consumers and parliamentarians.

Manufacturing cultivated meat involves replicating conditions inside the body of an animal in a bioreactor. This technique is called cell culture.[25] The volume of the bioreactor is commonly used to describe manufacturing capacity.[26]

Cell culture is widely used in the pharmaceutical industry. For example, vaccine development involves growing human cells outside of the body.[27] It is therefore possible to compare technologies and manufacturing capacity between these industries.

How is cultivated meat produced?

Figure 1 Cultivated meat production

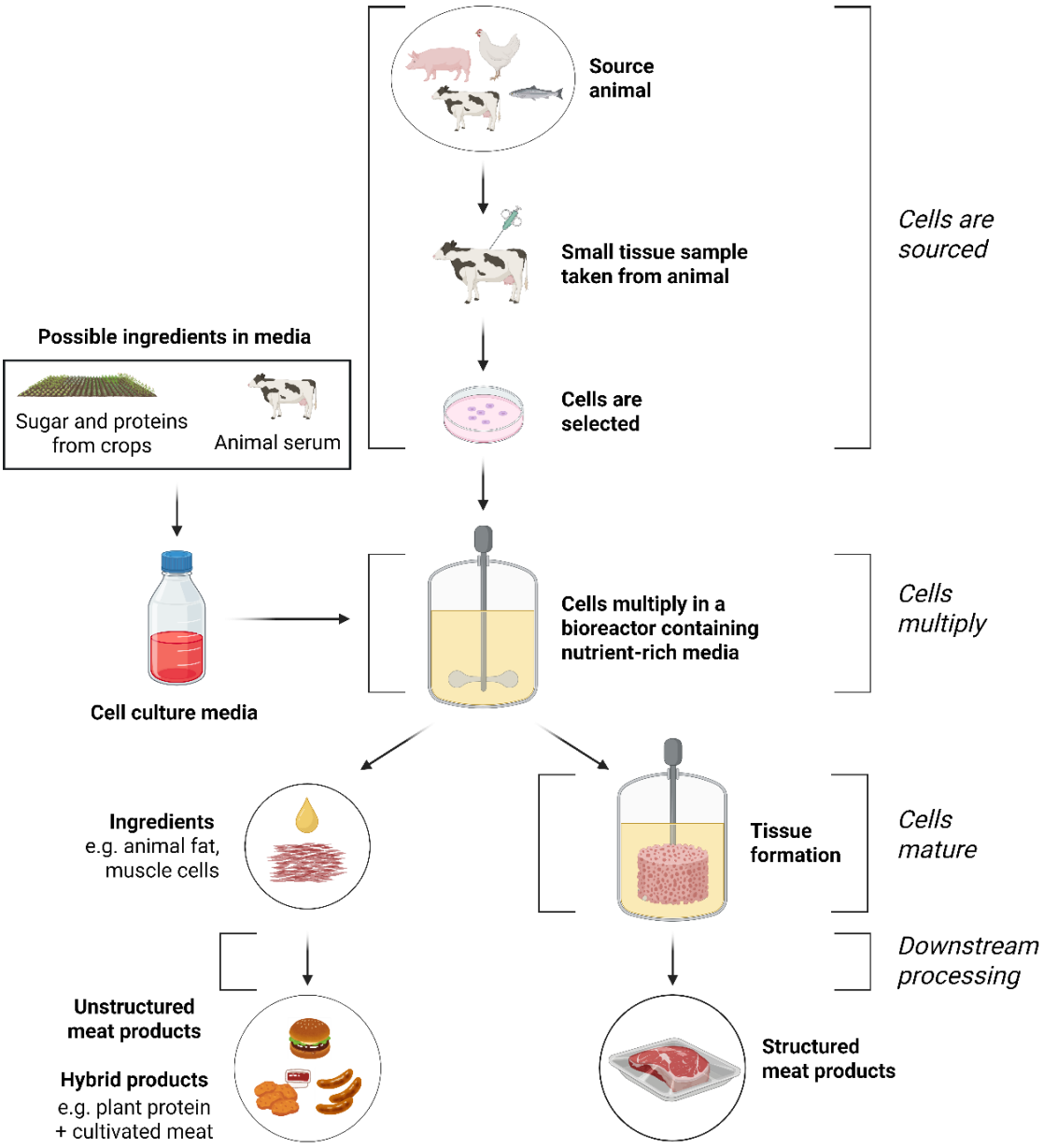


Image made with Biorender.

Cells are sourced

A biopsy, a small tissue sample of less than 1 gramme, is taken from a live or dead animal.[28–30]

The biopsy is processed in a laboratory to extract different cell types. Antimicrobials eliminate any contaminating microorganisms (see Public Health).[31]

Cells with desirable characteristics, such as stem cells,[32] are stored at low temperatures for future use in 'cell banks'.[33] This reduces the need to source new cells from animals.

Cells multiply

Cells are placed in a nutrient-rich medium in a bioreactor. The cells multiply, usually exponentially.

Standard media used to grow animal cells in pharmaceutical research can include fetal bovine serum (FBS), a liquid from the blood of an unborn cow.[34] The cultivated meat sector is developing alternatives to FBS (see Technology challenges).

Some nutrients found in meat, such as vitamin B12, might not be made by the cells being cultivated. These can be supplied by the media.[4]

Some cell types require a 'scaffold' to grow on.[35]

An unstructured mass of cells may be harvested at this stage and used in hybrid food products.[36]

Cells mature

Researchers have focused on producing cultivated muscle and fat tissues to replicate conventional meat products.[37,38]

Cells are cultured under conditions that promote maturation into different tissue types. This may involve scaffolds, hormones and growth factors.[39]

Downstream processing

Cells are separated from the medium and undergo processing to produce a product with a desired shape, texture, nutritional profile and taste.[40]

How much cultivated meat could be produced?

In the month of February 2025, UK beef, veal, mutton, lamb, pork and poultry production totalled 371,600 tonnes.[41] It is unclear if cultivated meat production will reach the scale of existing livestock systems (table 2).[19,42–44]

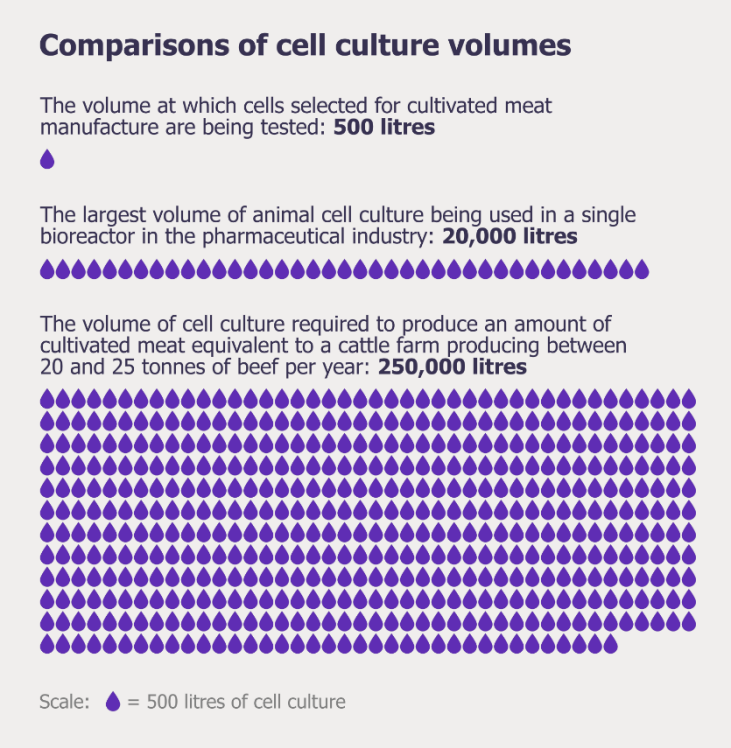
A 2024 review of cultivated meat found that:[42]

- cost estimates of cultivated meat vary from US$16 to $400,000 per kilogramme[g]
- a cultivated meat facility capable of producing 121,000 tonnes of cultivated meat per year would require an estimated capital expenditure between $1.58 billion and $10.7 billion[h]

Some studies indicate that technological advancements alone may not be sufficient for cultivated meat to compete with conventional meat products.[44,45]

The scale of production necessary for the commercial viability of cultivated meat is significantly greater than that commonly seen in the pharmaceutical sector (figure 2).[4,46]

Figure 2 Comparison of animal cell culture volumes in litres.[i]



Sources: Testing capacity, personal communication.[48] Pharmaceutical industry capacity, SJ Allan et al (2019).[30] Cattle farm equivalence, P Moutsatsou et al (2023).[j 51]

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[g] These estimates were made using models with different assumptions of technological, biological and economic factors. For example, one variable in the model was the rate at which the animal cells in the bioreactor multiplied.

[h] In 2023, the US Department of Agriculture reported it had spent $4.49 billion on capital expenditure in farming.

[i] In March 2025, Vow, an Australian cultivated meat company, announced it had cultivated animal cells in a 20,000 litre food-grade bioreactor.[47]

[j] In 2023 the average carcase weight for edible beef ranged from 81 kg (calves) to 342 kg (adult beef cows).[49] The average beef herd size in Britain is between 28 and 50 cows. Many commercial herds average 100 cows.[50] It would take the slaughter of 64 to 80 cows to produce between 20 tonnes and 25 tonnes of beef.

Technology challenges in cultivated meat production

As of April 2025, commercial quantities of cultivated meat cannot be cheaply produced.[46] Innovation in the following areas could reduce the costs.

Cells with specific features

Cell features that are essential for low-cost and high-volume manufacturing of cultivated meat include the ability to:

- multiply enough times for the desired production capacity, if not indefinitely
- mature into the desired tissue type, such as muscle
- withstand physical stresses associated with industrial-scale production[52]

According to academics, cells that possess all these features have not been identified.[42] Research in academia and industry is attempting to identify promising cell types from different species.[53,54,36]

Cell growth, maturation and capacity to multiply can be made more efficient by:

- optimising conditions inside bioreactors[55]
- engineering cells, including[56]
  - genome editing[k] [58]
  - changing how cells make proteins without changing their genetic code[59,60,61]
  - selecting cells that have spontaneously acquired favourable mutations[l]

Inexpensive media free of animal products

Studies routinely identify media as the most expensive component of cultivated meat production at scale. Estimates range between 31% to >99% of the cost per kilogram.[42]

For example, the common medium FBS is expensive and requires the slaughter of cows.[4]

Researchers are trying to develop media that are low cost, have a low environmental impact and are effective at encouraging cell growth and maturation.[62]

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[k] Genome editing is an umbrella term for a range of techniques used to introduce specific, targeted changes into the genetic code of an organism. Some changes may be identical to those that may occur naturally or that could be achieved through traditional selective breeding.[57] Products made using genome-edited cells may fall under genetically-modified organism regulations.

[l] Genetic mutations arise in cells without human intervention. Some mutations will mean the cells have useful properties. Laboratory techniques can select for these cells.

Different cell types require different media compositions. The most studied include ingredients made by plants and microbes.[m] [8,63] However, animal-free formulations available in 2024 have been cited as either expensive, less effective, or effective for only certain cell types.[42,64]

Researchers are investigating sourcing ingredients from agricultural and food processing byproducts and waste.[n] [70,71]

Processing technology

Commercial cultivated meat production requires bioreactors to work at scales and under conditions outside of the range of the pharmaceutical sector.[72]

Researchers are designing fit-for-purpose bioreactors[30,73–75] and food-grade scaffolds to improve yields.[76,77]

Different production systems being explored include

- decentralised, on-farm systems[78,79]
- contract manufacturers[80]
- centralised 'scale-up' systems, with one large bioreactor with a capacity of 10,000 litres to 20,000 litres
- centralised 'scale-out' systems,[81] using several smaller bioreactors (for example, with a 5,000 litre capacity) simultaneously

Sterility at scale

Researchers indicate there may be technological and manufacturing challenges to overcome to keep manufacturing sterile without using antimicrobials.[43] This includes standardising the purity of media ingredients.[43,82–84]

Food properties

Achieving a similar taste, smell and texture to conventional meat is a challenge in cultivated meat research.[38,85,86] As of April 2025, peer-reviewed findings on the sensory experience of cooking and eating cultivated meat are limited.[87–91]

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[m] Microbes, such as yeast cells, can be grown in bioreactors to produce chemicals, such as food additives like rennet. This is called precision fermentation. Cells may be genetically engineered to synthesise molecules they cannot produce naturally, such as human insulin made by engineered bacteria.

[n] Research into FBS alternatives include ingredients sourced from 'meal' and 'bran'. Meal refers to protein-rich material that remains after oil has been extracted from beans.[65] Bran refers to the outer layers of grains, often removed during processing.[66] Ingredients for media may be isolated from meal and bran from soybeans, rapeseed, cottonseed and peanuts.[67,68] A desk-based study evaluated how UK agricultural waste and by-products could be used to make media. It considered ingredients from rapeseed and cow blood, hoofs and horns.[69] Use of livestock byproducts means media is not free of animal ingredients.

Wider implications of cultivated meat

Uncertainty of implications

Environmental, health, social and economic implications of cultivated meat are difficult to predict because:

- food systems are highly complex (PN 702)
- cultivated meat is not being produced and sold at scale
- if cultivated meat was to be sold at scale in the UK, it is unclear how this might affect the consumption of conventional meat[o] [92]
- cultivated meat production methods and products differ[93]
- implications may be different in different regions[72,94]
- few published studies have considered the impacts of cultivated meat, with differing assumptions of:[95]
  - inputs that might be used in industrial production as media ingredients[93], such as algae or agricultural waste[74]
  - future technology developments, such as the availability of renewable energy[72,96]
- research is predominantly conducted by cultivated meat companies and may not be publicly available[96]

Environmental impacts

Life-cycle analyses (LCAs) are commonly used to estimate and compare environmental impacts of foods. Researchers suggest the limited availability of appropriate data in different contexts means LCA results are often uncertain (PN 702).[p] [98–100]

Results vary between the small number of LCAs looking at cultivated meat. All have modelled impacts of potential future production systems. It is hard to compare them because of differences in production methods, assumptions, and how impacts are allocated.[101] Comparisons made with conventional meat production may involve farming systems different from those in the UK.

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[o] Behaviour could include some consumers purchasing cultivated meat without reducing consumption of conventional meat and other consumers substituting conventional meat for cultivated meat.[92]

[p] LCA results can be affected by the location and food production system in question. The Eco Working Group, part of the UK Food Data Transparency Partnership, includes representatives from government, industry and academia. The group is considering how to standardise methodology and data collection relating to emissions in the food system.[97]

Land use

As of 2024, 16.8 million hectares in the UK are used for agriculture, accounting for 69% of total UK land area.[102] 57% of agricultural land is permanent grassland,[102] where dairy farming and rearing of cattle and sheep for meat are the principal farming activities.[q] [104]

Producing cultivated meat does not require land for pasture. It does require land to produce media ingredients, such as growing crops to produce sugar. Different ingredients have different land-use requirements.[72,101]

A 2023 LCA estimated cultivated meat to be more efficient than livestock at converting energy and nutrients in crops into edible meat. This conversion was seven times more efficient for cultivated meat than for beef cattle.[105]

LCAs consistently estimate lower land use for cultivated meat compared with cattle farming,[106,107,74,105] suggesting up to 95% lower land use.[105] Comparisons between cultivated chicken and poultry farming are inconclusive.[101,108]

Energy requirements

Cultivated meat production is an energy-intensive process. Total energy requirements depend on media ingredients and bioreactor design.[105] The production of synthetic media ingredients, such as synthetic amino acids, is particularly energy intensive.[93]

Cultivated meat production is estimated to require more industrial energy, such as electricity, heat or gas, than poultry and beef production.[74]

Greenhouse gas emissions

Greenhouse gas (GHG) emissions from cultivated meat production depend on energy sources used (for example, fossil fuels or renewable energy), production methods and media composition.[72,93,109,110]

As of 2024, agriculture accounts for around 12% of GHG emissions in the UK.[1] The two largest contributors of GHGs within the agricultural sector are:[111]

- methane from livestock and manure
- the release of nitrous oxide from agricultural soils (PN 710)

[q] The biggest direct use of land in livestock farming is for pasture and grazing. Additional agricultural land is required to produce feed. This figure does not include this use of land, nor the land used overseas to produce meat consumed in the UK. In 2010, 22% of UK agricultural land was used to grow livestock feed and 63% was grassland for livestock.[103]

Cultivated meat is estimated to have lower methane and nitrous oxide emissions per kilogramme of meat produced, but there is a wide range of estimates over how carbon dioxide emissions may compare.[r] [72,96,105,110]

Different GHGs have different lifetimes and warming effects in the atmosphere, therefore climate impacts depend on the timeframe analysed (PN 702).[s]

Water use

Livestock production in the UK primarily relies on rainwater.[112,113] In a 2010 report, researchers estimated that in the UK, on average, 'blue water'[t] use is 67 litres per kilogramme of beef carcase.[114]

It is uncertain how blue water use in cultivated meat production compares to this.[u] [101] But blue water use is predicted to be lower if water can be recycled.[105]

Waste and pollution

Manure from livestock farming can be used as an alternative to synthetic fertilisers and for biogas generation.[115]

Livestock waste can also pollute UK freshwaters (PN 661).[116] Agriculture was responsible for 87% of UK emissions of ammonia in 2022, with cattle responsible for 51% of these emissions.[1]

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[r] A 2023 LCA using industry data projected that renewable energy in cultivated meat production could reduce the carbon footprint of beef by up to 92% and pork by 44%.[105] The study also made assumptions about future technology and supply chains, such as sustainable amino acid production.

A 2024 LCA considered the global warming potential (GWP) of cultivated meat in carbon dioxide equivalent (CO_2e) emissions.[72] It found that different cultivated meat production methods had a GWP between 80% less and 2513% more than the median GWP of beef. All figures for cultivated meat in this later study were found to be greater than the minimum reported GWP for beef. The study did not consider potential technological advancements in cultivated meat production.

[s] Over 100 years, methane is 28 times more potent and nitrous oxide 26 times more potent than carbon dioxide in trapping heat. Methane has an atmospheric lifetime of 12 years. Carbon dioxide persists for hundreds to thousands of years. Within a 20-year period, methane traps 84 times more heat per mass unit than carbon dioxide, so the timeframe selected by a study affects how climate impact is quantified. A 2019 study used a 1000-year timeframe to evaluate the climate impact of cultivated meat.[110] The authors indicated that it is not yet clear whether cultivated meat would lead to less atmospheric warming than conventional meat.

[t] Blue water refers to water extracted from freshwater resources, such as lakes, rivers and aquifers. In agriculture this water is used for irrigation, livestock drinking water and cleaning. Use of blue water in regions of the UK subject to droughts can lead to water scarcity.

[u] A 2023 LCA analysed blue water use of cultivated meat under different scenarios, considering how different energy sources consume blue water, using industrial data.[105] When using renewable energy, cultivated meat was found to use 51% to 78% less blue water than conventional beef production, 22% more than chicken production, and 40% more than pork production. The study made assumptions of technical advancements in cultivated meat production. Comparisons were made to global estimates for the environmental impact of meat production from livestock.

The cost of UK agriculturally produced ammonia to human health and the environment in 2022 was £2.19 billion.[v] [1]

Cultivated meat production systems are 'closed', meaning waste generated during manufacturing can be contained and treated. Researchers are investigating how wastewater may be recycled or reused.[120,121]

Food security and climate resilience

In the UK, domestic meat production does not meet consumer demand.[w] [122] The UK imports some meat and animal feed.[123]

Feed availability and affordability can be affected by adverse weather and geopolitics.[124,125] This can affect domestic livestock supply.[123]

Domestic production of media ingredients could allow cultivated meat to complement domestic conventional meat production, potentially reducing meat and animal feed imports.[69,126]

It is unclear how the UK livestock sector will be affected by climate change.[127] However, heat stress in animals can lead to lower growth,[128] and the number of days per year that reach heat stress thresholds for different livestock is projected to increase across the UK.[129]

Climate change may increase the incidence of livestock pests and disease, such as sheep parasites.[130] The environment inside bioreactors is kept sterile so is not affected by pests and disease vectors.[131]

Controlled bioreactor temperatures mean cultivated meat production is less vulnerable to changes in climate. However, producing media ingredients from crops means cultivated meat production is still affected by climate change.[132] Climate impacts on crop yields could affect the availability of media ingredients, such as sugar.[133] Factors affecting energy availability could also affect production (PN 676).

Animal welfare

Researchers estimate that one 0.5 gramme tissue sample could be used to produce up to 5,000 tonnes of cultivated meat,[x] indicating that if scaled it would require far fewer animals to produce the same amount of meat as the livestock industry.[134,135]

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[v] Ammonia emissions harm human health and affect air quality, soil and vegetation.[117–119]

[w] Trade dynamics in the conventional meat industry are complex. The UK imports some cuts of meat to satisfy consumer demand, and exports others due to lower consumer demand. For example, lower value 'bone-in' cuts of meat are often exported, whereas higher value boneless cuts are often imported.[122]

[x] The paper predicts between 50kg to 5,000kg to 5,000,000kg. The variation is due to the specific cell type used.

Questions regarding animal welfare may include:[136–139]

- how many animals would be required for production
- what their welfare status would be
- whether animal ingredients are needed in media
- if conventional meat consumption patterns would change
- if so, the welfare status of the animals in the livestock production systems that would be affected

Food safety, nutrition and public health

Food safety

Consultations have identified potential food safety hazards[y] in cultivated meat production (table 2).[140–142] Risk is a focus of the Food Standards Authority sandbox.[23]

As companies scale production, 'good production practices' and industry standards are being developed to manage and assess safety.[84,143,144]

Table 2 Examples of hazards in cultivated meat production

Hazard	Potential mitigation and control measures	Comparison with conventional food production
Pathogens, such as bacteria, may be present in livestock tissue biopsies.	The animal's health can be checked, and small amounts of antimicrobials can be used when the biopsy is taken.	Pathogens are present in conventional food production, including meat production, and can lead to food-borne illnesses.
	Tests can check that extracted cells are free of pathogens. Sterility is maintained in cell culture.	Contamination can occur during the growth of the animal (such as infection of muscle) and during slaughter (such as intestinal bacteria mixing with meat cuts). This is a common source of food-borne illnesses.
	Harvesting cells might not involve slaughter, reducing the risk of contamination.	
	Contamination may occur during subsequent processing and packaging.	Contamination may occur during subsequent processing and packaging.

[y] Hazards are biological, chemical and physical agents present in food capable of causing adverse health effects. Identification is the first step in standard scientific risk assessment procedures, which involve understanding risks and developing mitigation measures.

Cultivated meat products may contain residues from substances used in the cell culture process, such as hormones and pH buffers, or chemical contaminants such as from plastic equipment.	Good practice, food-grade materials, rinsing cells and testing the final product can mitigate risk.	Any food that undergoes processing may contain residues. Risk assessments determine safety. Hormones and growth factors will be naturally present in conventional meat due to their roles in living tissues.
Allergens may be present in media, scaffolds and engineered cells.	If nutrients in media are derived from known allergenic sources, processing steps can reduce or eliminate allergens. Products must be labelled appropriately.	The allergen hazard and risk management strategy is the same as for conventional food production.
As cells multiply, mutations can occur. This 'genetic drift' may lead to unintentional changes to the original cell type, or result in increased levels of toxins or allergens.	Molecular biology techniques can monitor mutations and the presence of certain molecules. Allergenicity and toxicity testing can be conducted on the final product.	This hazard is also possible in conventional meat production because of mutations and genetic variation in livestock.

Source: Adapted from Food safety aspects of cell-based food, a 2023 report from the Food and Agriculture Organization and World Health Organization[142]

Nutrition

Meat is a source of digestible proteins, vitamins, minerals and fatty acids.[145] The nutritional profile of cultivated meat products is determined by the cells, media, scaffold and any added ingredients.[146] Studies have been conducted on these individual components and their impact on nutrient bioavailability[z].[148–150]

Evidence for the nutritional profile, digestibility and allergy risks of cultivated meat products is limited.[151]

Analyses by companies are not generally publicly available unless they are included in regulatory approval documents.[152]

As of February 2025, three laboratory investigations have been published on the nutrition of cultivated meat prototypes.[85,153,154] No peer-reviewed studies have investigated the effects of eating cultivated meat.

A 2025 review of nutrition compared the nutritional profile of conventional and cultivated meat (table 3).[146] It did not assess digestibility, which affects overall nutritional value.

[z] Bioavailability is defined as the fraction of a nutrient in a food that is absorbed and used in the body.[147]

Table 3 Nutritional profile of standard conventional meat products compared to cultivated meat. Values are per 100g of product.

Nutrient	Conventional meat		Cultivated meat				
			Academic research			Industry	
	Beef, lamb and pork	Poultry	Beef	Pork	Chicken	Chicken	Chicken
Proteins (g)	17.5 to 21.4	20.0 to 23.0	10.70	69.80	19.1	28.0	15.10
Total fat (g)	5.7 to 18.7	0.7 to 0.9	0.14	4.00	4.5	6.0	1.64
Iron (mg)	0.8 to 1.9	1.0 to 1.5	–	11.44	–	–	0.77
Zinc (mg)	1.8 to 3.7	1.2 to 2.4	–	6.22	–	–	2.47
Sodium (mg)	52 to 58	70 to 75	–	6400	346.2	400	263.00
Calcium (mg)	7 to 17	10 to 14	–	190	–	–	29.60

Source: Adapted from Lim et al (2025).[146] The values for cultivated meat products are from studies of individual prototypes or commercially available products. Empty cells indicate that data is not available. Ranges for conventional meat products reflect variation between different cuts. This data is from Pereira and Vicente (2022).[155]

A 2023 analysis of one cultivated chicken product indicated the need to improve reproducibility of the production process, as there was variation in nutrient levels between tested batches.[156]

Research into producing cultivated meat with enhanced nutritional qualities, such as products with more micronutrients and less saturated fat, is ongoing.[85,157,158]

Public health

Livestock production is a cause of the development of antimicrobial resistance and the spread of zoonotic disease, both of which affect human and non-human animal health (PN 701, PN 660).[aa]

Researchers do not expect cultivated meat production methods to increase these public health risks.[160–162]

It is unclear if consumers will adopt cultivated meat products into their diets, and if so whether this might encourage sustainable healthy diets.[bb] [164,165]

[aa] Globally, 70% to 80% of antibiotics (antimicrobials that kill bacteria) are used in farm animals.[3] The UK is one of the lowest users of antibiotics in livestock.[159]

[bb] The World Health Organization defines sustainable healthy diets as "dietary patterns that promote all dimensions of individuals' health and wellbeing; have low environmental pressure and impact; are accessible, affordable, safe and equitable; and are culturally acceptable".[163]

Perception of cultivated meat

Food and food production are part of culture, history, politics and personal values.[5]

Perspectives on cultivated meat are mixed.[166] Studies have predominantly used surveys or focus groups. Findings vary depending on the location, demographics of participants, and the framing and terminology used to describe cultivated meat.[167]

Public perspectives

Research into public perspectives has focused on identifying factors consumers would hypothetically consider if purchasing cultivated meat (PN 714).[167] These include price, taste, safety and health.[86,168–171]

Concerns cited include:[166,172–176]

- 'unnaturalness' of cultivated meat products
- disgust, lack of trust and an aversion to new food technologies
- fairness, technology ownership and implications for farmers and the rural economy
- whether cultivated meat products would be compatible with religious, vegan and vegetarian diets
- potential use of genome editing
- if cultivated meat would be an 'ultra processed' food (PB 59)

In a citizens' panel conducted for the 2025 Seventh Carbon Budget, participants favoured government support for innovation in alternative proteins (including 'lab grown meat').[170]

In February 2025, an FSA evidence review found that 16% to 41% of people would be willing to consume "cell-cultivated meat" in the UK.[168]

A 2024 FSA survey found that 46% of participants believed cultivated meat should not be sold in the UK.[177] Participants were "generally unsure" whether regulation would prevent the sale of unsafe cultivated meat.

A 2021 survey of 2,034 UK residents found 54% to have no familiarity with cultivated meat.[178] Information about cultivated meat has been shown to change public attitudes towards it, depending on the type of information provided.[94]

Farmers' perspectives

There is limited research into the perspectives of farmers.

One UK-based study is 'Culture Clash', a 2024 project which engaged with 80 farmers.

It found farmers' views on cultivated meat included uncertainty and concerns surrounding:[69]

- the feasibility of commercial production
- the reliability of data and projected implications
- if cultivated meat would complement or compete with conventional meat production
- who in the supply chain and wider food system would financially benefit from cultivated meat production

Potential economic implications

Many projections of economic implications have been funded by stakeholders in the cultivated meat sector. Some experts are sceptical of economic claims and indicate that expectations may be inflated.[179,180]

According to SystemsIQ,[cc] the global cultivated meat market could be valued at £426 billion by 2050, with Asia-Pacific being the main driver of growth.[181]

Contributors stated that international cultivated meat producers are engaging with UK companies, indicating the potential to export products and services.[48]

Cultivated meat industry stakeholders and think tanks suggest that workforce implications could include[182,183]

- the creation of high productivity jobs in research and manufacturing
- indirect support of some farming jobs due to the requirement for inputs from the agricultural sector

Potential implications for the rural economy

Cultivated meat products include items with different prices, markets and production systems.[dd] Potential implications for the rural economy depend on which, if any, of these products scale (see Uncertainty of implications).[69]

Because of the infrastructure and costs involved in producing cultivated meat, large-scale centralised manufacturing is most likely to result in products with prices similar to conventional meat products.[94,184]

Several researchers have indicated that if the sector was to scale in this way, large companies are most likely to benefit. This is hypothesised to reduce rural

[cc] SystemsIQ is a consultancy. The study was commissioned by the Good Food Institute (GFI) Europe, an alternative protein think tank.

[dd] For example, cultivated meat products may include cultivated steaks, cultivated chicken nuggets and cultivated foie gras. The conventional production of these items involves different numbers of farm workers and different profit margins.

employment and agricultural income from livestock farming and to shorten supply chains, with less demand for meat processors.[94,167,185–187]

Other researchers have proposed smaller scale 'on-farm' manufacturing models with more opportunities for the rural economy.[78,167]

Impacts on livestock farming may also affect industries supplying and relying on non-edible outputs from the sector, such as leather and manure.[185]

The 'Culture Clash' study explored hypothetical challenges and opportunities for farmers (table 4).[69]

Table 4 Examples of hypothetical challenges and opportunities for farmers presented by cultivated meat

Challenges for farmers	Effects on 'carcase balance'[ee], the value meat from cows not reared for beef, if cultivated meat was to replace cheaper meat products
	Reduced demand for arable crops and grain used for animal feed caused by potential displacement of livestock
	Risks to livestock health from taking biopsies from live animals
	Reduced availability of local services (such as fencers and vets) and amenities in rural communities that rely on livestock farming
Opportunities for farmers	Supply of cultivated meat inputs, such as media ingredients and animal cells, and the opportunity to derive value from agricultural waste (such as oilseed rape meal, cow blood, and hoof and horn meal).
	Small-scale on-farm cultivated meat production, with the potential to derive value from repurposed infrastructure.
	Alternative uses of land which could lead to income, such as for renewable energy generation or rewilding.
	Competitive edge for farmers producing conventional meat, which consumers may be willing to pay more for than cultivated meat.

Source: Adapted from Macmillan et al (2024)[69]

[ee] 'Carcase balance' refers to making use of every part of an animal carcase, including 'in demand' cuts, 'non-demand' cuts, commodity products (such as meat for pet food) and by-products (such as blood and bones), to ensure costs are less than, or at least equal to, income.

Regulation of cultivated meat

UK regulation of cultivated meat

In the National Vision for Engineering Biology policy paper, UK industry stakeholders said that lack of clarity regarding the regulatory process and timelines for approvals were "stifling" the sector.[22]

The variety of cultivated meat products and production methods mean that different regulations may apply to each. Most applications are expected to fall under existing novel food regulation (figure 3).[11] Cultivated meat products would also need to align with regulation applicable to all foods, such as hygiene rules.[11] Approvals for production facilities may require collaboration with regulators in addition to the FSA.[ff]

The UK Government is working with regulators regarding the approval of novel foods.[gg] [22]

The FSA sandbox aims to address challenges associated with regulating cultivated meat by gathering scientific evidence and perspectives.[hh] [191]

The FSA is working with industry representatives, academics and civil society groups to develop guidance on:

- the approvals process
- safety hazards and mitigating tests
- outstanding regulatory questions, such as labelling

The sandbox also aims to:

- complete risk assessments for at least two cultivated meat applications
- form a UK cross-government network[ii]
- form an international regulators' forum[jj]

[ff] The UK approval of hybrid cultivated pet food in July 2024 involved the FSA, Department for Environment, Food & Rural Affairs (Defra) and the Animal and Plant Health Agency.

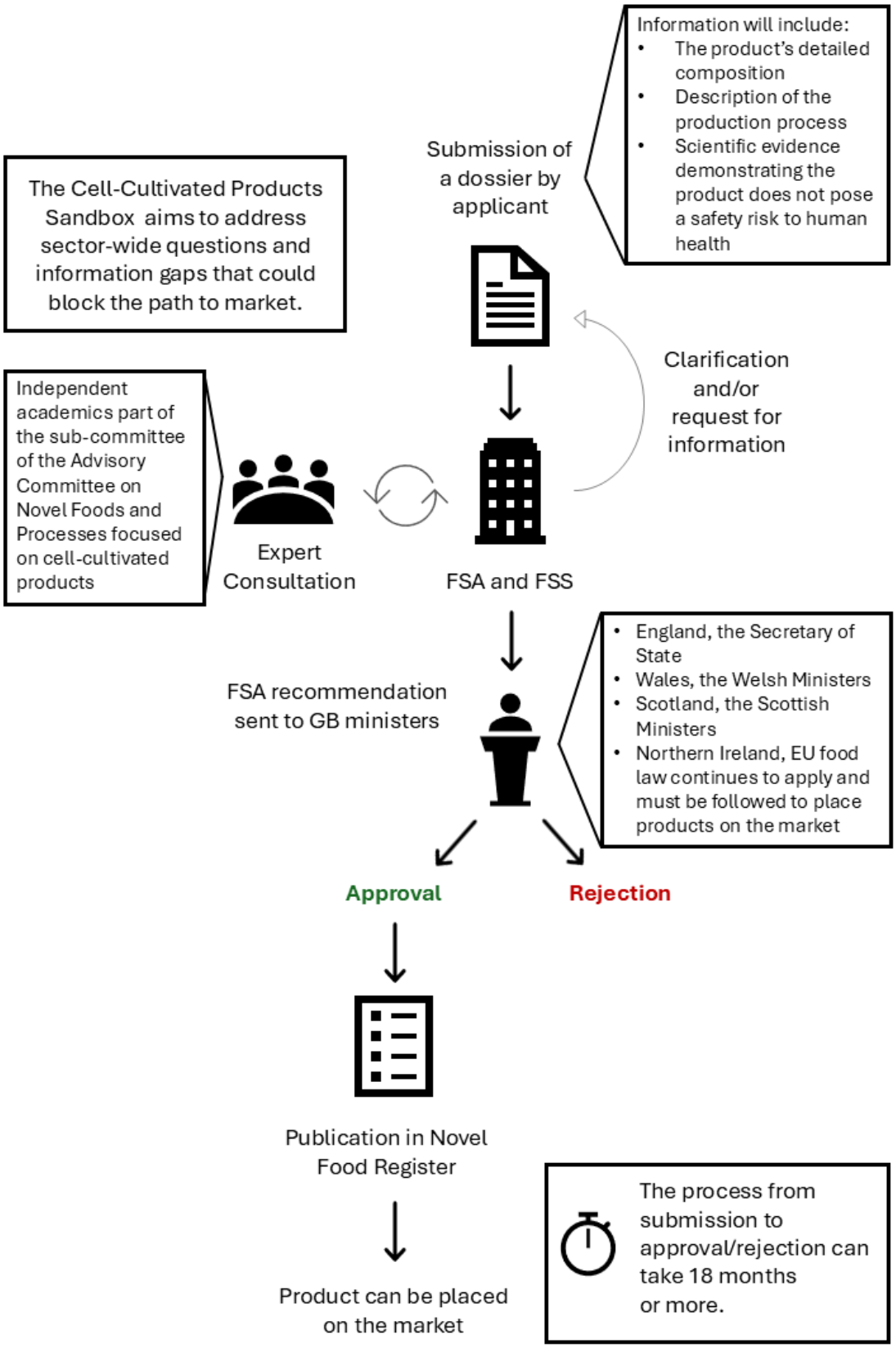
[gg] The Regulatory Innovation Office was established in October 2024 and will consider products made using 'engineering biology' technologies, which includes cultivated meat.[188] A review of the novel foods framework to support alternative protein innovation was in the Cabinet Office's 2022 'The Benefits of Brexit' report.[189]

[hh] This includes 'other legitimate factors' in addition to human health risk assessment. These may include economic impacts, technical and feasibility considerations and consumer habits and perceptions.[190]

[ii] The network will address regulatory issues relating to cell-cultivated products beyond the remit of consumer safety.

[jj] The forum will address questions about cell-cultivated product regulation and allow participants to share insights.

Figure 2 Novel food regulation in the UK



Source: FSA guidance[11,192] and personal communication[193]

International regulation of cultivated meat

The absence of international regulatory alignment has been identified as a challenge to the commercial development of the sector.[194,195]

Cultivated meat is a politically sensitive issue. This has led to products being approved in some jurisdictions and banned in others (table 5).

Table 5 International regulation of cultivated meat

Country	Year	Regulatory Decision	Further detail
Singapore	2020	Approval of cultivated chicken for human consumption.	Hybrid shredded chicken product (made from plant protein and 3% cultivated chicken) in an independent butcher. Produced by Eat Just, a US company.[196]
USA	2023	National approval of cultivated chicken for human consumption.	Limited tasting runs of chicken pieces at select restaurants were paused in February 2025. Produced by Eat Just and Upside Foods, US companies.[197,198]
Italy	2023	Legislation bans production, sale and import of cultivated meat.	The Minister for Agriculture and Food Sovereignty stated that the bill was to protect culture and tradition.[199] The Italian bill violated EU scrutiny procedures.[200]
Singapore	2024	Approval of cultivated quail for human consumption.	An alternative to foie gras (made with plant protein and 51% cultivated quail cells) produced by Vow, an Australian company.[201] Available at select restaurants.
Israel	2024	Approval of cultivated beef steak for human consumption.	Aleph Farms, an Israeli company, has received regulatory approval. As of April 2025 the product is not yet available.[202]
UK	2024	Approval of cultivated chicken for pet food.	Limited release of chicken dog treats (made with plant protein and 4% cultivated chicken) produced by Meatly, a UK company. Available at a pet store in London in February 2025.[203]
Hong Kong	2024	Approval of cultivated quail for human consumption.	An alternative foie gras (made with 51% cultivated quail and plant protein) produced by Vow, an Australian company is available at select restaurants.[204]
USA	2024 to 2025	State-level bans of cultivated meat	Politicians in Mississippi, Alabama and Florida have banned the sale of cultivated meat, citing concerns about implications for livestock farmers. As of April 2025, other states have proposed bans.

Cultivated meat in the UK

The UK cultivated meat sector includes academic research centres (table 6) and companies involved in both developing cultivated meat products and supporting its manufacture (figure 4).[22,205,206]

According to the Good Food Institute Europe, an alternative protein think tank, the cultivated meat sector in the UK had:

- the third highest number of companies (16) in 2023, after the USA (45 companies) and Israel (19 companies)[207]
- the most patents filed in Europe between 2014 and 2024[208]
- the most published papers, citations and researchers in Europe between 2019 and 2023[209]

Between 2020 and mid-2024, UK public investment in cultivated meat research was £30 million.[kk 193]

Table 6 UK research centres focusing on cultivated meat

Name	Funding (£ millions)	Funder	Funding period
Cellular Agriculture Manufacturing Hub (CARMA)	12	Engineering and Physical Sciences Research Council	2023 to 2030
Bezos Centre for Sustainable Protein	24	Bezos Earth Fund, a USA-based philanthropic organisation	2024 to 2029
National Alternative Protein Innovation Centre (NAPIC)	16	Biotechnology and Biological Sciences Research Council and Innovate UK	2024 to 2029

Source: Good Food Institute (GFI) Europe[210]

[kk] This figure includes £12 million of investment into the Cellular Agriculture Manufacturing Hub (CARMA). The primary focus of CARMA is cultivated meat research. Other alternative protein research is also conducted.

Infrastructure and investment

Facilities for research and development are available in the UK, but contributors highlighted prohibitive costs and limited bioreactor capacity as barriers to their use.[16]

UK 'scale-up' facilities for cultivated meat have a bioreactor capacity of 50 litres to 5000 litres.[80]

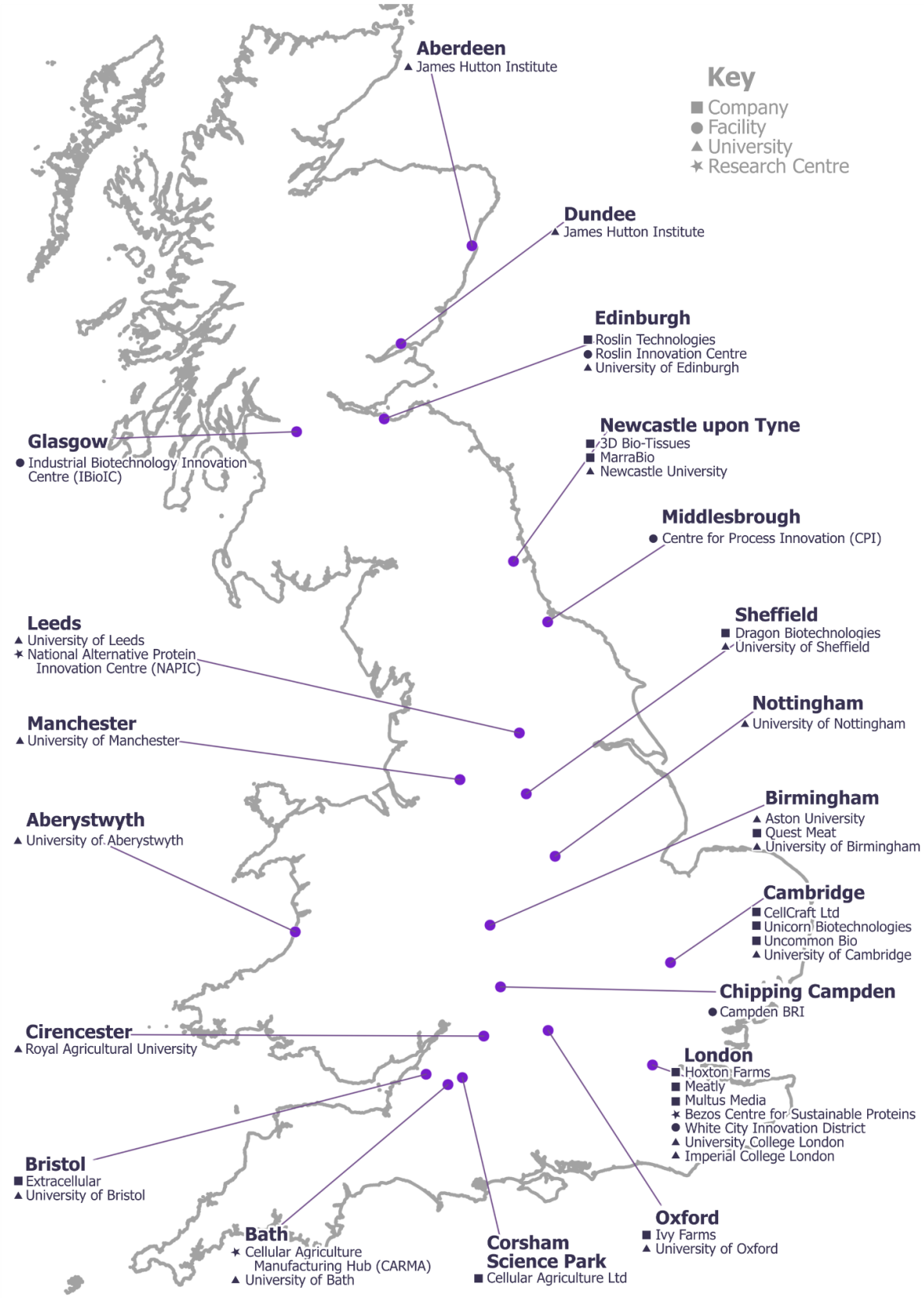
Access to larger facilities, such as pilot plants, is necessary to generate data to obtain patents and investment, and optimise production.[21]

As of April 2025, several UK cultivated meat companies have constructed private pilot plants, with venture capital as a primary source of funding.[211–214]

The lack of facilities and funding available in the UK for manufacturing and scale up means some companies have expanded their operations abroad.[21,215]

Industry stakeholders indicated that government support can help 'de-risk' the sector, however uncertainties over the viability of cultivated meat production at scale remain (see How much cultivated meat could be produced?).[21]

Figure 3 Overview of some private and public groups engaged in UK cultivated meat research [II]



[II] There are no relevant organisations in Northern Ireland.

The groups displayed in figure 4 are provided below for accessibility.

Category	Name	Location
Company	Hoxton Farms	London
Company	Ivy Farms	Oxford
Company	Cellular Agriculture Limited	Corsham Science Park
Company	Meatly	London
Company	Quest Meat	Birmingham
Company	Multus Media	London
Company	Uncommon Bio	Cambridge
Company	Extracellular	Bristol
Company	3D Bio-Tissues	Newcastle
Company	Dragon Biotechnologies	Sheffield
Company	Unicorn Biotechnologies	Cambridge
Company	CellCraft Ltd	Cambridge
Company	MarraBio	Newcastle
Company	Roslin Technologies	Edinburgh
Research Centre	Cellular Agriculture Manufacturing Hub (CARMA)	Bath
Research Centre	National Alternative Protein Innovation Centre (NAPIC)	Leeds
Research Centre	Bezos Centre for Sustainable Proteins	London
Facility	Campden BRI	Chipping Campden
Facility	Centre for Process Innovation (CPI)	Middlesbrough
Facility	Roslin Innovation Centre	Edinburgh
Facility	Industrial Biotechnology Innovation Centre (IBioIC)	Glasgow
Facility	White City Innovation district	London
University	Universtiy of Manchester	Manchester
University	University of Birmingham	Birmingham
University	University College London	London
University	University of Cambridge	Cambridge
University	University of Oxford	Oxford
University	Newcastle University	Newcastle

University	Imperial College London	London
University	Aston University	Birmingham
University	University of Bath	Bath
University	University of Edinburgh	Edinburgh
University	University of Leeds	Leeds
University	University of Sheffield	Sheffield
University	Royal Agricultural University	Cirencester
University	The James Hutton Institute	Aberdeen and Dundee
University	University of Nottingham	Nottingham
University	University of Aberystwyth	Aberystwyth
University	University of Bristol	Bristol

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