# Sample & recruitment

We solicited interest from the following groups, with the aim to arrive at six forecasters:

* Top 10 forecasters on Metaculus
* Top 10 forecasters on Metaculus within the last 12 months
* [Twitter outreach for cultured meat scientists](https://web.archive.org/web/20220212221904/https://twitter.com/LinchZhang/status/1451714079706411013)

# Email sent to selected forecasters on Wed, Oct 27, 2021

Dear forecasters,

Thank you so much for being willing to help Rethink Priorities with our cultured meat forecasts. We believe having accurate forecasts on this can help save many animals.

Please do the following:

1. Read the main [forecasting questions here](https://docs.google.com/document/d/1s-7DsqDQeotxLRJ7YEGbs6wBSNURxgdCvS1FJloisyU/edit?usp=sharing)
2. Make a copy of [this spreadsheet](https://docs.google.com/spreadsheets/u/1/d/1z0HJlSAOZZWmp_muuIRZpeSUbCbu9jBF3S_IgV7jjjg/copy) for your answers.
3. As soon as possible, **confirm whether you can still commit to spending 15 hours to forecast all of the questions before November 17 2021.**
   1. Please let us know as soon as possible if you need to back out so we can find replacements.
4. Send us questions as they arise
   1. In particular, for question operationalization clarifications, it’s better to send them earlier rather than later, so we can update this for all forecasters.

We recommend starting on these questions sooner rather than later. I (Linch) have personally found starting these questions to be harder than average for forecasts.

Note that Rethink Priorities is planning to submit these forecasts as well as our own forecasts and analysis of them to the relevant parties, as well as write a public report. **We will credit you by name by default**, but let us know if you prefer to be known either anonymously or pseudonymously.

We will pay you $45/hour for the first 15 hours of work by default. Please let us know ahead of time if you think you need to take more than 15 hours or much less than 15 hours.

**Please reply to this email if you have any questions.**

Cheers,

Linch

# Copy of questions document (written in October 2021)

# Instructions

* We would like you to make predictions on all of the 29 questions below
* Please enter your answer and your reasoning in the Google Sheet [here](https://docs.google.com/spreadsheets/u/1/d/1z0HJlSAOZZWmp_muuIRZpeSUbCbu9jBF3S_IgV7jjjg/copy) (this will automatically ask you to make a copy of it). We are interested in identifying the cruxes for more optimistic/pessimistic views, so your reasoning will help us greatly with this.
* Email us back your completed Google sheet and any other materials you think are relevant
* We advise you to look through all the questions before starting to predict
* We have included some relevant baseline reference information for questions below and a list of [existing questions on Metaculus](#_7tjd9w43hs5z). If you wish to not read our extra reference information then only read the questions on the Google sheet and not the questions in this document.
* Please take no more than **~15 hours within ~2-3 weeks** on this.
* You’re welcome to consult friends and other experts, but please do not post these questions publicly.
* Edited questions are in red.

# Why these questions and not others

* Linch and Neil spent a bunch of time considering which forecasting questions are most likely to be decision-relevant to major philanthropic parties we are in contact with. Past work and forecasting questions have had different stakeholders and theories of change in mind, so their questions are less directly useful for us.
* In particular, prior work on cost-competitive clean meat forecasting has focused on price targets, but we’ve operationalized questions on either (price, volume) pairs or just pure volume. Our reasoning is that we can’t trust claimed prices for low volumes as venture capitalists (VCs) can burn [$$s on subsidies for small volumes](https://www.cnbc.com/2020/12/18/singapore-restaurant-first-ever-to-serve-eat-just-lab-grown-chicken.html) so we believe that restaurant or storefront prices are a poor signal for ultimate cost-competitiveness. Other questions have asked about maximum production *capacity*, which are premised on worlds where input costs are as cheap as possible. We think it is less useful than actual production.
* We have intentionally chosen to define cultured meat products as being made mostly from cellular meat (see below) rather than plant-based meat with small cultured meat or fat additions. We think this more cleanly fits with the theory of change that cultured meat is worth spending more resources on, especially in worlds where displacement won’t occur among significant portions of consumers unless the product is mostly animal meat. If we have a moderate causal effect in creating common knowledge that the long-term aim of cellular meat companies is to create plant meat with cultured flavor additions, this will be helpful (assuming this is the correct thing for them to do)

# Fine print for all questions

* All weight figures refers to 70% wet mass unless otherwise specified
* All statements are asking for a probability unless otherwise specified
* All $ figures are in 2021 [inflation-adjusted USD](https://www.usinflationcalculator.com/) unless otherwise specified ($ numbers pegged to 2021 USD but not PPP adjusted for location, as we believe is standard)
* Cellular meat defined as >51% of the “meat” is produced directly from animal cells (as opposed to plant protein, yeast, farmed animals)[[1]](#footnote-0)
* All figures are global unless otherwise stated
* cellular/cultivated/cultured/cell-cultured/clean/lab-grown meat are interchangeable terms
* Cellular meat refers to any type of cut (ground meat or whole tissue like chicken breast or beef steak)
* These questions are conditional on no [transformative artificial intelligence](https://www.openphilanthropy.org/blog/some-background-our-views-regarding-advanced-artificial-intelligence) or globally catastrophic disaster (the human population decreases by at least 10% during any period of 5 years or less occurring by the date in question). Note that by "transformative artificial intelligence" we mean AI-obviously-identifiable-as-such before with effects clearly comparable to or greater than the first industrial revolution: AI that precipitates either (a) economic growth of >=30% per year for at least a few years or, conversely, (b) an irreversible extinction, curtailment, or a plateau of human growth and potential". Advances in AI with effects similar to the introduction of electricity or the internet should not be excluded, and you may wish to explicitly model it[[2]](#footnote-1) in your calculations (if you assume this is sufficiently likely).

# Please read this

Recent studies show that some people tend to act differently when they face hypothetical decisions. In other words, they may say one thing but do something different. For example, some people would state a price they would pay for an item, but when this item becomes available in the grocery store, they will not pay this price. There can be several reasons for this behavior, including acquiescence bias where the participant gives the answer they think the survey maker wants to hear. We want you to behave in the same way that you would if you really had to bet on the prediction with real significant amounts of your own money or reputation. Please take into account how much you really rate a probability, as opposed to other alternatives. Please respond to each of the following questions as if you were really on a forecasting platform with real stakes.

# List of questions

## Questions about **production volume**

* The first 4 questions are about cow cells, because that’s the baseline that some of the studies go off of, and we want to compare like for like if possible.
* Resolution via:
  + Industry statistics from credible sources akin to the FAO & USDA (such as independent credible outside analysts, governments, inter-governmental agencies, the FAO itself, & The Good Food Institute's market research reports.)
* As reference: 100 metric **kilo**tons = 100,000 metric tons = 100,000,000 kg.

### Reference material

* *Individual company estimates:*
  + Estimates from back in 2017 that suggest labs were growing [120](https://www.foodnavigator.com/Article/2017/05/11/First-lab-grown-meat-made-in-Russia) to >[450](https://www.theguardian.com/small-business-network/2017/jul/24/lab-grown-food-indiebio-artificial-intelligence-walmart-vegetarian) grams/year). MeaTech/Peace of Meat said it is capable of producing over [700 grams](https://thespoon.tech/alt-protein-round-up-tofurkys-algae-based-products-and-animal-free-chicken-fat/#:~:text=MeaTech%20is%20now%20producing%20animal,in%20a%20single%20production%20run.) of cell-based chicken fat in a single production run (which probably takes a month, ~0.008 metric tons/year).In contrast, large-scale precision fermentation (PF) “means production on the scale of grams to a few kilograms . . . a large PF batch would be in the order of 1kg to a few tons.”([RethinkX, 2019](https://static1.squarespace.com/static/585c3439be65942f022bbf9b/t/5d7fe0e83d119516bfc0017e/1568661791363/RethinkX+Food+and+Agriculture+Report.pdf)).
  + SuperMeat [claimed](https://globetrender.com/2020/11/20/cultured-meat-on-the-menu-at-the-chicken-restaurant-in-tel-aviv/) their pilot plant has the *capacity* to “produce several hundred pounds of chicken per week” which could be in the tens of metric tons/year.
  + Future Meat has claimed their [factory](https://www.jns.org/5000-burgers-a-day-worlds-first-cultured-meat-production-plant-opens-in-israel/) opened in June 2021 has production *capacity* of ~130 to ~182 metric tons per year, though there have not been any public production batches as of this writing, except for a [tasting](https://www-timesofisrael-com.cdn.ampproject.org/c/s/www.timesofisrael.com/israel-to-be-represented-at-glasgow-climate-talks-by-120-strong-delegation/amp/) by the Israeli delegation to COP26.
  + GOOD Meat’s Josh Tetrick said their upcoming [Qatar facility](https://www.foodfrontier.org/eat-just-to-build-cultivated-meat-facility-in-qatar/), which could take [until 2023](https://www.bloomberg.com/news/articles/2021-08-31/eat-just-to-build-cultured-meat-plant-in-qatar-amid-global-pushhttps://www.bloomberg.com/news/articles/2021-08-31/eat-just-to-build-cultured-meat-plant-in-qatar-amid-global-push) to complete, will be able to produce ~[4,500 metric tons per year](https://thecounter.org/lab-grown-cultivated-meat-cost-at-scale/), though we believe they currently produce [a couple hundred kg/year](https://thecounter.org/lab-grown-cultivated-meat-cost-at-scale/) in their existing commercial operations in Singapore.
  + In August 2019, BlueNalu released a [five-stage commercialization strategy](https://www.bluenalu.com/pr-82219) that plans to break ground on a large-scale facility in five years (2026) that when complete (by 2028-2029?) can produce ~8,000 metric tons of finished cultivated seafood products per year, but they are aiming for [11 metric tons/year](https://thespoon.tech/bluenalu-announces-new-expanded-facility-to-bring-its-cell-based-seafood-to-test-markets/) with their existing pilot plant due to get up and running in late 2021.
  + WildType [announced](https://www.fooddive.com/news/cell-based-meat-plants-come-online-for-future-meat-technologies-and-wildtyp/602301/) their pilot plant in San Francisco in 2021 is operational which they claim will be able produce 22.7 metric tons/year (not stated by when) but has a maximum *capacity* of 90.7 MT/year.
  + A GFI [survey](https://gfi.org/resource/cultivated-meat-media-growth-factor-survey/), fielded in December 2020, of cultivated meat companies found (of 17) 35% expected to produce 0 to 1kg of wet cell mass over the next 12 months, 41% anticipated 1 to 10kg, 18% 10 to 100kg, and 6% 100 to 1,000 kg. Taking the upper bounds, this implies just 1.4 metric tons total for 2021 among these 17 companies. If the full 80 cultured meat companies followed this same distribution (which seems optimistic) it would be a total of 6.7 metric tons.
  + In a 20 April 2021 Foodnavigator [article](https://www.foodnavigator-asia.com/Article/2021/04/20/Cultured-meat-future-Why-government-buy-in-is-crucial-for-sector-to-hit-production-cost-parity-by-2030), Senior scientist at GFI Dr Elliot Swartz, when talking about the facilities modelled in the the [CE Delft TEA](https://cedelft.eu/publications/tea-of-cultivated-meat/) which produce 10,000 metric tonnes annually of cultivated meat, is quoted as saying "the facility in the [study] is very large in terms of its volumetric capacity - it is highly likely that most facilities in the next 10 years will be smaller than this"
  + Also see Metaculus estimates for [2023](https://www.metaculus.com/questions/7036/cultivated-meat-production-capacity-2023/) and [2030](https://www.metaculus.com/questions/7035/cultivated-meat-production-capacity-2030/) single facility maximum production *capacity*.
* *Consultancy predictions on global production:*
  + [McKinsey (2021](https://www.mckinsey.com/industries/agriculture/our-insights/cultivated-meat-out-of-the-lab-into-the-frying-pan)) predicts 400K to 2.1M metric tons by 2030
  + [BCG (2021)](https://web-assets.bcg.com/a0/28/4295860343c6a2a5b9f4e3436114/bcg-food-for-thought-the-protein-transformation-mar-2021.pdf) implies 116K metric tons by 2030 (our calculations)
  + [AT Kearney (2020)](https://www.de.kearney.com/consumer-retail/article/?/a/when-consumers-go-vegan-how-much-meat-will-be-left-on-the-table-for-agribusiness-) implies 3.5M metric tons by 2030 (our calculations).
  + GFI [thinks](https://gfi.org/wp-content/uploads/2021/04/COR-SOTIR-Cultivated-Meat-2021-0429.pdf) the industry will move from hundred of metric tons 2019-2020 to thousands of metric tons from 2022, and millions sometime after when it reaches “industrial scale”. Plus they said “In the next 5, 7, 10 years we will likely see the industrial scale production of meat” ( in the millions between 2026-2031) ([YouTube version](https://youtu.be/6cAcuse6Gzs?t=672) in 2021).
  + Supplying 10% of the global market by 2030 (40M metric tons) is according to Blake Bryne, former Business Innovation Specialist at GFI, “´not out of step´with some industry analysts, consulting firms, and investment banks, which have made projects in this industry” ([Foodnavigator, 2021](https://www.foodnavigator.com/Article/2021/08/13/Cell-based-disruption-How-many-factories-and-at-what-capacity-are-required-to-supply-10-of-the-meat-market)).
  + FAIRR ([2021](https://www.fairr.org/article/appetite-for-disruption-a-second-serving/)) Credit Suisse ([2021](https://www.credit-suisse.com/media/assets/microsite/docs/responsibleinvesting/are-research-report.pdf)), and Barclay’s ([2019](https://eu30.salesforce.com/sfc/p/#1t000000wCuV/a/1t000000Xg33/q3Bm_z_oiIm8K7s4mnGLApU.WpmqvU6rEsBaiqGRob4)) have also produced projections for the entire alternative protein market, including but not limited to cellular meat.

### Questions

1. >100 metric kilotons of Cow-cell based cellular meat will be sold at any price within a continuous 12-month span before the end of 2031.
   1. 2020 estimate of total USA plant-based meat production was

90 metric kilotons ([Shapiro 2020](https://paulshapiro.medium.com/just-how-much-meat-is-plant-based-a80478faa95f#:~:text=Best%20estimates%20of%20U.S.%20plant,U.S.%20meat%20production%20by%20volume.%E2%80%9D), this [paywalled page](https://www.meatingplace.com/Industry/AnalogueDish/Details/92534) from Meatingplace Lewis Bollard cites in his [newsletter](https://us14.campaign-archive.com/?u=66df320da8400b581cbc1b539&id=cea38367f1))

* 1. [BCG claims](https://web-assets.bcg.com/a0/28/4295860343c6a2a5b9f4e3436114/bcg-food-for-thought-the-protein-transformation-mar-2021.pdf) 13M metric tons of alternative protein (meat, seafood, milk, eggs, and dairy, excluding pulses, tofu, and tempeh) were consumed globally in 2020.

1. >100 metric metric kilotons of Cow-cell based cellular meat will be sold at any price within a continuous 12-month span before the end of 2036.
2. >100 metric kilotons of Cow-cell based cellular meat will be sold for <$10/kg wholesale on average within a continuous 12-month span before the end of 2031.
   1. Beef (ground chuck) is in the [$5/kg](https://www.beefitswhatsfordinner.com/resources/wholesale-price-update)-$[15/kg](https://www.ams.usda.gov/mnreports/lsmngfbeef.pdf) range (conventional to grass fed)
3. >100 metric kilotons of Cow-cell based cellular meat will be sold for <$10/kg wholesale on average within a continuous 12-month span before the end of 2036.

* - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -

1. >100 metric kilotons of cellular meat will be sold at any price within a continuous 12-month span before the end of 2031
2. >100 metric kilotons of cellular meat will be sold for <$10/kg wholesale on average within a continuous 12-month span before the end of 2031.
   1. Composite wholesale broiler is around $[1.50/kg](https://www.nationalchickencouncil.org/about-the-industry/statistics/wholesale-and-retail-prices-for-chicken-beef-and-pork/). Pasture-raised retail chicken (fresh backs) is as low as [$4.20/kg](https://maplewindfarm.com/store/product/retail-chicken-backs)
   2. The wholesale selling price of Quorn’s mycoprotein (*Fusarium Venenatum*) products is [~$3/kg wet](https://forum.effectivealtruism.org/posts/y8jHKDkhPXApHp2gb/cultured-meat-a-comparison-of-techno-economic-analyses?commentId=BGCvr6axDsu33aeTq), and the production cost of baker's yeast is ~$1.80/kg dry ([Humbird 2020](https://www.researchgate.net/publication/348009195_Scale-Up_Economics_for_Cultured_Meat_Techno-Economic_Analysis_and_Due_Diligence)). 1M metric tons/year of baker’s yeast (*S. cerevisiae*) is produced just in Europe ([Parapouli et al, 2020](https://www.ncbi.nlm.nih.gov/pmc/articles/PMC7099199/))
   3. Our understanding is that the Beyond and Impossible are selling their plant-based products for [$15](https://www.independent.ie/business/farming/agri-business/agri-food/impossible-foods-cuts-wholesale-prices-for-plant-based-burger-by-15pc-for-second-time-in-one-year-39938975.html)-[$25](https://www.ft.com/content/20ae8314-e1fa-4bcb-b2c0-99e58df6bfb7)/kg, but cheaper options exist such as Gardein Beefless ground for ~[$8.50](https://us14.campaign-archive.com/?u=66df320da8400b581cbc1b539&id=cea38367f1)/kg retail.
   4. Good Meat sold cultured chicken nuggets for [~$198 to $1,000/kg](https://twitter.com/joshtetrick/status/1340298046932832256), at a loss. Biotech Foods claimed it can produce at [$112/kg](https://www.foodprocessing.com/articles/2021/cultured-meat/).Future Meat has claimed it is in the [$40/kg to $68/kg](https://www.ft.com/content/ae4dd452-f3e0-4a38-a29d-3516c5280bc7?segmentId=98583035-ac35-a0ba-ed44-378e53f8caec) range and Shiok Meats in the [$35/kg](https://www.latimes.com/food/story/2020-10-08/lab-shrimp-meat) to [$50/kg](https://www.fairr.org/article/appetite-for-disruption-a-second-serving-webinar/) range (note that these may not be >50% CM products. Future Meat was aiming for a 45% chicken product, and a 60% lamb product)
3. >100 metric kilotons of cellular meat will be sold at any price within a continuous 12-month span before the end of 2036
4. >100 metric kilotons of cellular meat will be sold at any price within a continuous 12-month span before the end of 2051.
5. >1M metric tons of cellular meat will be sold at any price within a continuous 12-month span before the end of 2031
   1. Equivalent today to 1% of both the US and EU livestock production or if just under 1% of global poultry production was cellular
6. >1M metric tons of cellular meat will be sold at any price within a continuous 12-month span before the end of 2036
7. >1M metric tons of cellular meat will be sold at any price within a continuous 12-month span before the end of 2051.
8. >10M metric tons of cellular meat will be sold at any price within a continuous 12-month span before the end of 2036.
9. >10M metric tons of cellular meat will be sold at any price within a continuous 12-month span before the end of 2051.
10. >50M metric tons of cellular meat will be sold at any price within a continuous 12-month span before the end of 2051.

## Questions about **consumer adoption**

1. Conditional upon >10 cumulative metric kilotons (i.e. >10,000 metric tons) of cellular meat produced at any price before the end of 2031, will there be large-scale protesting (at least 100,000 people within a 14 day period, including one protest of at least 10,000 people, within national boundaries of the USA, China, India, UK or an EU country) before the end of 2041 explicitly against cellular meat products, according to credible media reports (Agence France-Presse (AFP), Associated Press (AP), BBC News, Reuters and EFE)?
2. Conditional upon >10 cumulative metric kilotons (i.e. >10,000 metric tons) of cellular meat produced at any price, will >50% of a representative sample of US, China, *or* EU survey respondents say they are willing to try cellular meat in 2031 according to a [survey group/research institute](https://faunalytics.org/consumers-cultured-meat-a-review-of-literature-from-2018-2020/) deemed credible by Open Philanthropy?
   * 1. Resolves ambiguous if no survey made
     2. Uses the result of the best survey (subjectively judged) per country/region if multiple surveys are made per country/region
     3. Resolves yes if any of the up to 3 surveys made

## Question about **intermediate goals**

* Cultured meat companies reportedly received ~[$625M private investment so far in 2021](https://twitter.com/elliotswartz/status/1442540678232395780), and ~$1B in total 2015-2021 ([GFI, 2020](https://gfi.org/resource/cultivated-meat-eggs-and-dairy-state-of-the-industry-report/)).
* ~[$6bn](https://gfi.org/wp-content/uploads/2021/05/COR-SOTIR-Plant-based-meat-eggs-and-dairy-2021-0504-1.pdf) was raised 1980-2020 for plant-based protein (meat, eggs, dairy)
* GFI records [$12.8 million](https://gfi.org/blog/tracking-alt-protein-research-grants/) in non-dilutive grants for open-access research from governments 1999-2021 (though we believe the total amount is 10x higher for total government funding into cultured meat companies and research - other funding allocated, converted to USD,: [$2.3M](https://vegconomist.com/cultivated/e2m-eu-grant-brings-nutreco-mosa-meat-closer-to-launching-cultivated-beef-in-europe/), [$4M](https://www.vlaio.be/nl/nieuws/kerstmenu-2024-foie-gras-uit-het-labo), [$3.5M](https://thespoon.tech/food-tech-news-innerplant-launches-sensor-plants-3-5-million-grant-for-cultivated-meat/),$[3.2 M](https://www.foodnavigator.com/Article/2020/10/14/EU-assigns-first-ever-funds-for-cultured-meat-project#),$[3M](https://techcrunch.com/2019/12/06/dutch-startup-meatable-is-developing-lab-grown-pork-and-has-10-million-in-new-financing-to-do-it/?guccounter=1&guce_referrer=aHR0cHM6Ly9tZWRpdW0uY29tL2NlbGxhZ3JpL21lYXRhYmxlLXJhaXNlcy1hZGRpdGlvbmFsLWZ1bmRpbmctdG8tZGV2ZWxvcC1jZWxsLWJhc2VkLXBvcmstMTU4MjIwOWIxNzk3&guce_referrer_sig=AQAAAMgMNG4D7I3apw-JScRH6eTXUyG7d_ZX9P322iq6W1YCWF7Dg_byrTPxA6jPC-WBMhmTf11j7AL86hAI0BrUh0ebcSorGMgztY5GhACJqodwWNWugjB6KGwgjF_nDpIBOeVR3h2txv8mGoPDaQw_7zbgK6fp5fwZjTUp0n-Rn6UN) ,$[2.2M](https://thespoon.tech/integriculture-awarded-2-2-million-grant-to-build-new-commercial-cell-ag-facility/) [$50M](https://www.straitstimes.com/singapore/68m-fund-to-turn-labs-into-food-factories-of-the-future),[$3M](https://icelandmonitor.mbl.is/news/news/2020/08/01/icelandic_biotech_firm_receives_large_european_gran/), [$2M](https://books.google.co.uk/books?id=D-PaDwAAQBAJ&pg=PA123&lpg=PA123&dq=million+euro+funding+in+vitro+meat+%222004%22+%22netherlands%22+%22matheny%22&source=bl&ots=wQEjt2cQbY&sig=ACfU3U0CdVkzuhLD0qmRZsN3w0Q1oOE7-w&hl=en&sa=X&ved=2ahUKEwjy--mmw57wAhWYUBUIHXqhDP8Q6AEwEHoECAYQAw#v=onepage&q=million%20euro%20funding%20in%20vitro%20meat%20%222004%22%20%22netherlands%22%20%22matheny%22&f=false), [$4M](https://web.archive.org/web/20111102144404/http://www.theaustralian.com.au/news/health-science/test-tube-meat-sciences-next-leap/story-e6frg8y6-1111112859219), [$10M](https://twitter.com/GoodFoodInst/status/1448377934062968840), [$6M](https://www.foodnavigator.com/Article/2021/01/20/Spanish-government-invests-5.2-million-in-cultured-meat-project)).

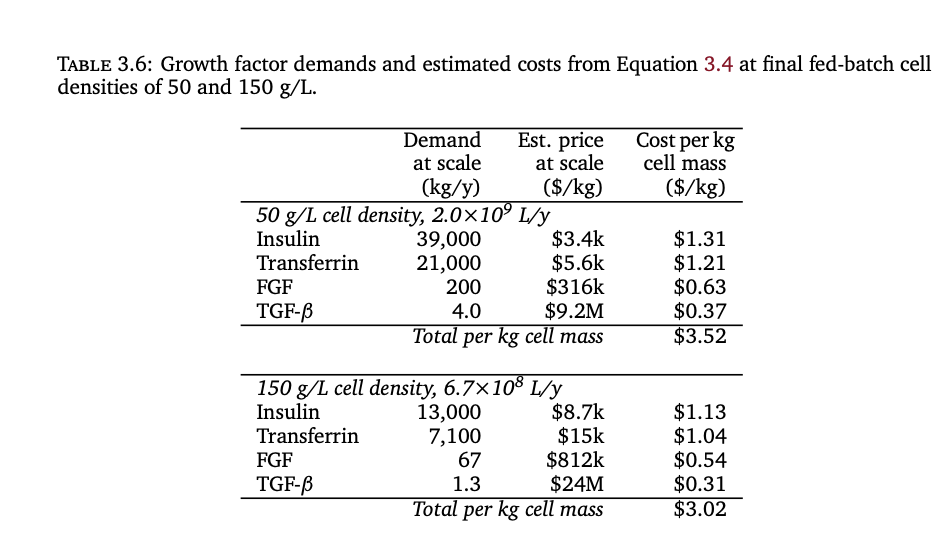
1. Will at least two companies in our list of top biotech Venture Capitalists ([Arch](https://www.archventure.com/), [Flagship](https://www.flagshippioneering.com/), [Atlas](https://atlasventure.com/), [Third Rock](https://www.thirdrockventures.com/)) each lead a funding round of total size >$100M USD in a cellular meat company, OR credible evidence of >$3B USD total in funding rounds for cellular meat companies with participation from at least two of the predefined top biotech VCs before the end of 2031?
2. Will the US federal government have allocated[[3]](#footnote-2) at least $1B across a 12-month period to fund cellular meat research before the end of 2031?
   1. In 2021 October the USDA awarded TuftsUniversity [$10M](https://twitter.com/GoodFoodInst/status/1448377934062968840) to establish the National Institute for Cellular Agriculture
   2. In 2020 September UC Davis received a [$3.5M](https://www.greenqueen.com.hk/cultivated-meat-research-at-uc-davis-awarded-usd-3-5m-u-s-government-grant/) grant from the National Science Foundation to research cultivated meat.
3. Will the EU[[4]](#footnote-3) have allocated at least $1B across a 12-month period to fund cellular meat research before the end of 2031?
   1. In 2021 October the EU allocated [$2.3M to MosaMeat](https://vegconomist.com/cultivated/e2m-eu-grant-brings-nutreco-mosa-meat-closer-to-launching-cultivated-beef-in-europe/)
   2. In 2020 October the EU allocated [~$3.2M](https://www.foodnavigator.com/Article/2020/10/14/EU-assigns-first-ever-funds-for-cultured-meat-project#) from it’s Horizon 2020 program to a cultivated meat research programme led by a Spanish cultured meat company
   3. In 2020 August an Icelandic (a non-EU country) cultured meat growth factor company received [$2.9M](https://icelandmonitor.mbl.is/news/news/2020/08/01/icelandic_biotech_firm_receives_large_european_gran/) from the European Commission
   4. In 2019 December the European Commission provided a [$3M](https://techcrunch.com/2019/12/06/dutch-startup-meatable-is-developing-lab-grown-pork-and-has-10-million-in-new-financing-to-do-it/?guccounter=1&guce_referrer=aHR0cHM6Ly9tZWRpdW0uY29tL2NlbGxhZ3JpL21lYXRhYmxlLXJhaXNlcy1hZGRpdGlvbmFsLWZ1bmRpbmctdG8tZGV2ZWxvcC1jZWxsLWJhc2VkLXBvcmstMTU4MjIwOWIxNzk3&guce_referrer_sig=AQAAAMgMNG4D7I3apw-JScRH6eTXUyG7d_ZX9P322iq6W1YCWF7Dg_byrTPxA6jPC-WBMhmTf11j7AL86hAI0BrUh0ebcSorGMgztY5GhACJqodwWNWugjB6KGwgjF_nDpIBOeVR3h2txv8mGoPDaQw_7zbgK6fp5fwZjTUp0n-Rn6UN) grant to a Dutch cultured meat company
   5. Eurogroup for Animals, one of the oldest lobbying groups in Brussels, [recently](https://www.eurogroupforanimals.org/what-we-do/areas-of-concern/cultivated-meat) started raising the issue of cultured meat.
4. Will official Chinese national government sources claim to have allocated at least $1B across a 12-month period to fund cellular meat research before the end of 2031?
   1. In 2017: a [$300M](https://futurism.com/china-signed-a-300-million-lab-grown-meat-deal-with-israel) trade deal between China and Israel for cultured meat imports
   2. An [estimated](https://www.cingta.com/detail/20304) $3.1 M of a 2020 National Key R&D Program titled [“Green Biological Manufacturing”](https://service.most.gov.cn/u/cms/static/202009/17143654cpj3.pdf) will be specifically aimed at developing alternative protein
   3. In June 2021, a three-year government-funded project titled “High-efficiency biological manufacturing technology of artificial meat” was [announced](https://service.most.gov.cn/kjjh_tztg_all/20210621/4363.html).
   4. GFI APAC also found that many plant-based and cultivated meat research teams have received funding through the National Natural Science Foundation of China (unclear how much) ([GFI, 2021](https://www.gfi-apac.org/blog/look-closer-china-is-quietly-making-moves-on-cultivated-meat/))
5. Will there be more than 250 Principal Investigator and PhD student full time equivalents working on cellular meat in 2036 (working in a lab, degree, or project dedicated to cellular meat), according to sources Open Philanthropy deems are credible?
   1. As of 2021 October, GFI lists [37 cultured meat labs](https://gfi.org/resource/research-labs-database/) and [60 researchers](https://gfi.org/resource/collaborative-researcher-directory/) open to working on cultured meat.
   2. In 2021 October, the USDA awarded Tufts University [$10M](https://twitter.com/GoodFoodInst/status/1448377934062968840) to establish the National Institute for Cellular Agriculture
   3. In 2021 October, Singapore's A\*STAR Research [announced](https://www.linkedin.com/posts/a-star-bti_singapore-bti-astar-activity-6856051803935641600-PRMI) a dedicated “CentRe of Innovation for Sustainable banking and Production of cultivated Meats​ (CRISP Meats)” focused on public-private partnerships.
6. “Impartial Effective Animal Advocacy evaluators” (a majority opinion among Kieran Greig, Karolina Sarek, Alexandria Beck, Mikaela Saccoccio)[[5]](#footnote-4) in 2036 will consider that a marginal $10M donated between 2021 to 2026 would have been better spent on cellular meat rather than plant-based meat.
7. “Impartial Effective Animal Advocacy evaluators” (a majority opinion among Kieran Greig, Karolina Sarek, Alexandria Beck, Mikaela Saccoccio) in 2036 will consider that a marginal $10M donated between 2021 to 2026 would have been better spent on cellular meat rather than increasing spending in a dollar-weighted average of Open Phil’s existing farmed animal welfare donations.

### Inputs

* GFI fielded a [survey](https://gfi.org/resource/cultivated-meat-media-growth-factor-survey/) in 2020 December of cultivated meat manufacturers (19) and suppliers of culture media components or formulations (21). Most suppliers (54% of 15 who answered) expected the average cost per liter of medium to still be over $5 by December 2021. 20% expected it to be <$0.50. 90% believed the lowest production cost of media they can achieve in the next 12 months is $10-$50. 63% thought it would be below <$5 in the next 5 years.
* Page 16 of this [Agronomics slidedeck](https://web.archive.org/web/20210924193353/https://agronomics.im/wp-content/uploads/2020/12/Agronomics-Corporate-Presentation-2020-6.pdf) citing GFI’s Liz Specht ([2019](https://gfi.org/wp-content/uploads/2021/01/clean-meat-production-volume-and-medium-cost.pdf)) includes a “current” media price of $10/L.
* At the 2021 Good Food Conference, Laurus Bio (an integrated research-driven biomanufacturing organization with deep expertise in microbial precision fermentation and recombinant proteins) said it was [targeting](https://www.youtube.com/watch?v=IH1a1wOdCfk&ab_channel=TheGoodFoodInstitute) $1/g for albumin, transferrin and $100/g for growth factors
* Nutreco, a major animal feed company, has invested in BlueNalu and MosaMeats and believes feed grade media can perform just as well as pharma-grade, but much cheaper. It provided the example of L-Lysine; Pharma grade $264/kg, Food grade $29/kg, Feed grade $3.50/kg ([Good Food Conference, 2021](https://youtu.be/IH1a1wOdCfk?t=2399)).

1. Will reputable sources estimate that growth factors (inclusive of but not limited to FGF2, TGF-β) contribute less than $1/kg wet mass on average to the production of cellular meat in 2031?
   1. Cost estimates from the techno-economic analyses [we’ve read](https://rethinkpriorities.org/publications/cultured-meat-a-comparison-of-techno-economic-analyses):

| **Costs ($/kg)** | [Ce Delft:Baseline](https://cedelft.eu/wp-content/uploads/sites/2/2021/04/CE_Delft_190254_TEA_of_Cultivated_Meat_Def.pdf) | [Risner, et al](https://acbmcostcalculator.ucdavis.edu/) | Humbird |
| --- | --- | --- | --- |
| FGF2 | 1.3B-2.3B | 1B-2.1B | 316K-812K |
| TGF-β | 3.7B-5B | 80.9B | 9.2M-24M |



1. Will reputable sources estimate that amino acids other than growth factors (inclusive of but not limited to the form of individual amino acids, vegetable hydrolysate, and recombinant proteins) contribute less than $20/kg wet mass on average to the production of cellular meat in 2031?
   1. Linch’s [Twitter outreach](https://twitter.com/LinchZhang/status/1420238165097385985)
      1. Note that 100x may be on the large end of estimates
   2. Cost estimates from the techno-economic analyses [we’ve read](https://rethinkpriorities.org/publications/cultured-meat-a-comparison-of-techno-economic-analyses):

| **Costs ($/kg)** | [Ce Delft:Baseline](https://cedelft.eu/wp-content/uploads/sites/2/2021/04/CE_Delft_190254_TEA_of_Cultivated_Meat_Def.pdf) | [Risner, et al](https://acbmcostcalculator.ucdavis.edu/) | Humbird |
| --- | --- | --- | --- |
| Insulin | 155K-400K | 340K | 3K-9K |
| Transferrin | 246K-400K | 400K | 5K-15K |
| amino acids/base media | 0.40-50 | 0.24-376/L | 3.39-87 |

### Outputs

1. Will one of the top ten largest discount store chains by revenue (akin to today’s Target, Aldi, Lidl, Trader Joe's, Save-A-Lot Grocery Outlet, Costco, Walmart) sell cellular meat own-brand goods at any price before the end of 2031, according to credible industry reports?
2. Will a well-known US Quick Service Restaurant (Subway, McDonald's, KFC, Pizza Hut, Burger King, Domino’s, Hunt Brothers Pizza, Taco Bell, Wendy's, Hardee's, Chick-fil-A, Chipotle, Little Caesars, Dunkin, Starbucks, Baskin Robbins) offer a cellular meat product in at least 3 locations concurrently serving at least twice a week for a period of at least 3 months at any price before the end of 2031?
   1. A quick service restaurant is said to feature a cellular meat product on its menu, if, in at least 3 locations that are open to the public, any member of the public is able to order the product, without requiring a reservation or unconventional process such as a lottery. The product must be for sale, and free samples do not count. "Pop-up" restaurants that exist for a very short amount of time (such as those at a convention like [CES](https://www.ces.tech/)) do not count toward resolution.
   2. KFC [claimed](https://www.triplepundit.com/story/2020/kfc-lab-grown-nuggets/121021) in 2020 it was planning to test 3D printed lab-grown chicken in Russia.

### Other

1. In 2051, would we believe that a Manhattan project for cultured meat in 2021 would have been successful?
   1. In 2051, will a panel of Effective Altruism-trusted experts think that counterfactually, a cellular meat project started in 2021-2026 with $28 billion dollars & at least three Nobel Prize winning scientists would have resulted in technological breakthroughs that eventually directly led to >5% global meat displacement in 2051?
2. What will total global conventional meat and seafood production be in 2051 in millions of metric tons (80% credible interval i.e. 80% probability that the true value is between this range, take the values at the 10th and 90th percentile of your distribution).
   1. See OurWorldinData [meat production](https://ourworldindata.org/grapher/global-meat-production) ([by livestock type](https://ourworldindata.org/grapher/global-meat-production-by-livestock-type)) & [seafood production](https://ourworldindata.org/seafood-production)

# Cellular meat questions already on forecasting platforms

* [What will be the largest cultivated meat product production capacity, in metric tons per year, of a single production facility, by January 1st, 2023?](https://www.metaculus.com/questions/7036/cultivated-meat-production-capacity-2023/)
* [What will be the largest cultivated meat product production capacity, in metric tons per year, of a single production facility, by January 1st, 2030?](https://www.metaculus.com/questions/7035/cultivated-meat-production-capacity-2030/)
* [What will the lowest retail price, in USD per kg, of any product containing 50% clean meat be, in the calendar year 2026?](https://www.metaculus.com/questions/3103/what-will-the-lowest-retail-price-in-usd-per-kg-of-any-product-containing-50-clean-meat-be-in-the-calendar-year-2026/)
* [What will the lowest retail price, in USD per kg, of any product containing 50% clean meat be, in the calendar year 2029?](https://www.metaculus.com/questions/3104/what-will-the-lowest-retail-price-in-usd-per-kg-of-any-product-containing-50-clean-meat-be-in-the-calendar-year-2029/)
* [When will more than half of the main broad types of conventional ground meats will have at least one cost-competitive cultured alternative, in years after 2020?](https://www.foretold.io/c/0104d8e8-07e4-464b-8b32-74ef22b49f21/m/35caf084-9436-49c3-a046-eea6a8c8bf7a)
* [How much revenue will the U.S. market for clean meat generate, in the fiscal year 2027, in millions of USD?](https://www.metaculus.com/questions/3065/how-much-revenue-will-the-us-market-for-clean-meat-generate-in-the-fiscal-year-2027-in-millions-of-usd/)
* [How much revenue will the U.S. market for clean meat generate, in the fiscal year 2030, in millions of USD?](https://www.metaculus.com/questions/3077/how-much-revenue-will-the-us-market-for-clean-meat-generate-in-the-fiscal-year-2030-in-millions-of-usd/)
* [How much venture capital, private equity, and other non-exit capital will be invested in cultivated meat companies in 2022](https://www.metaculus.com/questions/7049/2022-non-exit-investment-in-cultivated-meat/)
* [How many months after the first clean meat company is first valued at ≥ $1bn will there be at least three companies valued at a billion dollars or more?](https://www.metaculus.com/questions/3062/how-many-months-till-at-least-three-billion-dollar-clean-meat-valuations-after-the-first-such-company-is-first-valued-at--1bn/)
* [When will there be a public clean meat co?](https://www.metaculus.com/questions/3058/when-will-there-be-a-publicly-listed-clean-meat-company/)
* [When will there be a publicly listed clean fish company?](https://www.metaculus.com/questions/3059/when-will-there-be-a-publicly-listed-clean-fish-company/)
* [How many research papers on cultivated meat will be published, according to Semantic Scholar in 2022](https://www.metaculus.com/questions/7043/new-cultivated-meat-publications-by-2022/)
* [Will McDonald's offer cultivated meat first?](https://www.metaculus.com/questions/7056/will-mcdonalds-offer-cultivated-meat-first/)
* [Prop. of QSR with cultivated meat in 2026?](https://www.metaculus.com/questions/7055/prop-of-qsr-with-cultivated-meat-in-2026/)
* [When will a restaurant first serve clean-meat products containing ≥20% clean meat, at $3 per 100 grams or cheaper?](https://www.metaculus.com/questions/3081/when-will-a-restaurant-first-serve-clean-meat-products-containing-20-clean-meat-at-3-per-100-grams-or-cheaper/)
* [When will a restaurant first serve clean-meat products containing ≥80% clean meat, at $3 per 100 grams or cheaper?](https://www.metaculus.com/questions/3086/when-will-a-restaurant-first-serve-clean-meat-products-containing-80-clean-meat-at-3-per-100-grams-or-cheaper/)
* [When will two or more supermarkets sell products made of ≥20% clean fish in their physical retail stores in at least 25 U.S. states?](https://www.metaculus.com/questions/3447/when-will-two-or-more-supermarkets-sell-products-made-of-20-clean-fish-in-their-physical-retail-stores-in-at-least-25-us-states/)
* [When will a supermarket sell a product made of ≥20% clean meat, for $3 per 100 grams or cheaper?](https://www.metaculus.com/questions/3087/when-will-a-supermarket-sell-a-product-made-of-20-clean-meat-for-3-per-100-grams-or-cheaper/)
* [When will a supermarket sell a product made of ≥80% clean meat, for $3 per 100 grams or cheaper?](https://www.metaculus.com/questions/3088/when-will-a-supermarket-sell-a-product-made-of-80-clean-meat-for-3-per-100-grams-or-cheaper/)
* [Will an incumbent traditional animal protein company take out a full-page ad that criticises plant-based, or cultivated meat, in either the NYT, WSJ or WaPo by 2023?](https://www.metaculus.com/questions/7058/anti-alt-food-adds-by-2023/)
* [How many countries will approve the commercial sale of cultivated meat by 2023](https://www.metaculus.com/questions/7066/-countries-to-sell-cultivated-meat-by-2023/)
* [Will at least one cultivated meat product be for sale in the US by 2023?](https://www.metaculus.com/questions/7065/us-sale-of-cultivated-meat-by-2023/)
* [When will at least 5 cultivated meat products be approved by federal regulators for commercial sale in the US?](https://www.metaculus.com/questions/7064/5-cultivated-meat-products-sell-in-the-us/)
* [Will there be a 50% decline in global meat production by 2040?](https://www.metaculus.com/questions/7314/50by40-meat-production-goal-achieved/)
* [How many commercial cattle, in millions, will be slaughtered in the U.S. in 2032 if the lowest retail price of clean meat in 2026 is between $8 and $20 per kg?](https://www.metaculus.com/questions/3115/how-many-commercial-cattle-in-millions-will-be-slaughtered-in-the-us-in-2032-if-the-lowest-retail-price-of-clean-meat-in-2026-is-between-8-and-20-per-kg/)
* [How many commercial cattle, in millions, will be slaughtered in the U.S. in 2032 if the lowest retail price of clean meat in 2026 is less than $8 per kg?](https://www.metaculus.com/questions/3113/how-many-commercial-cattle-in-millions-will-be-slaughtered-in-the-us-in-2032-if-the-lowest-retail-price-of-clean-meat-in-2026-is-less-than-8-per-kg/)
* [How many commercial cattle, in millions, will be slaughtered in the U.S. in 2032 if the lowest retail price of clean meat in 2026 is greater than $20 per kg?](https://www.metaculus.com/questions/3153/how-many-commercial-cattle-in-millions-will-be-slaughtered-in-the-us-in-2032-if-the-lowest-retail-price-of-clean-meat-in-2026-is-greater-than-20-per-kg/)
* [Date of decline of CAFOs by 90%](https://www.metaculus.com/questions/7319/date-of-decline-of-cafos-by-90/)
* [Meat or dairy tax in the US or EU by 2023?](https://www.metaculus.com/questions/7068/meat-or-dairy-tax-in-the-us-or-eu-by-2023/)
* [A decrease in US meat production by 2025?](https://www.metaculus.com/questions/281/a-decrease-in-us-meat-production-by-2025/)

1. Future Meat is aiming to have a 45% chicken product & a 60% lamb product, and the rest 40-55% plant protein and water respectively ([FoodNavigator, 2021](https://www.foodnavigator.com/Article/2021/06/23/Our-goal-is-to-make-cultured-meat-affordable-for-everyone-Future-Meat-Technologies-opens-facility-gears-up-for-2022-launch)). The former would not count, the latter would. [↑](#footnote-ref-0)
2. Eg, AI assisted bioreactor design or metabolic engineering [↑](#footnote-ref-1)
3. Funds need not have been spent [↑](#footnote-ref-2)
4. Allocated from a program initiated or approved by any of the EU institutions (Commission, Parliament, Council) and implemented by an EU agency or EU member state, but excluding independent funding that EU member states make outside of such programs. [↑](#footnote-ref-3)
5. EA Animal Welfare fund manager as accessed 2021/07/15 on, minus Lewis Bollard and Marcus A. Davis. https://web.archive.org/web/\*/https://funds.effectivealtruism.org/funds/animal-welfare#fund-managers [↑](#footnote-ref-4)