

The science of cellular agriculture-cultured meat and precision fermentation



PROTEIN 2.0 END CONFERENCE DECEMBER 2022



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Background



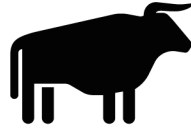
Production of biosynthetic macromolecules (single protein, precision fermentation, cultured meat) is expected to increase dramatically in the years to come



The (disruptive) potential of biosynthesized macromolecules has led many to conclude that we need to prepare for its arrival.



Cellular Agriculture



Animals



Plants



Microbes

Cellular products



Food
(Cultured meat)



Materials
(Leather)



Cosmetics

Acellular products



Food
(Gelatin, milk,
egg white)



Chemicals
(Insulin,
Vanillin)

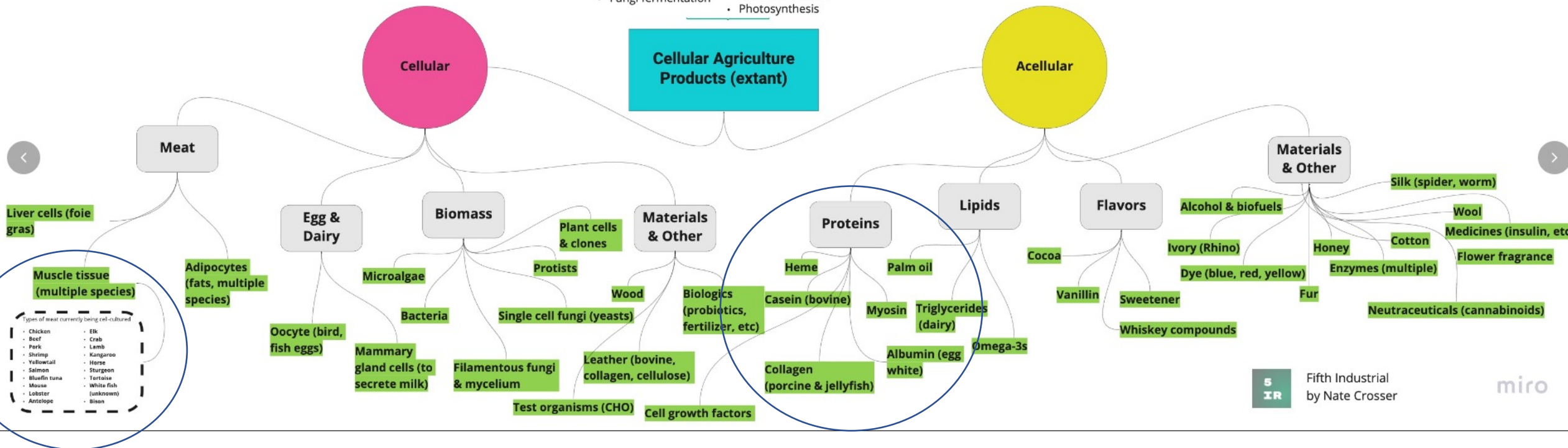


Materials
(Leather,
Silk, wood)

Cellular agriculture will help feed the world

- Feedstocks**
- Sugar (beet, corn, cane)
 - Lignin/cellulose
 - Methane/CO2
 - Other agro-industrial side-streams/starches
 - Photosynthesis
- Production Platforms**
- Animal cell culture
 - Plant cell culture
 - Microbial fermentation
 - Fungi fermentation

Cellular Agriculture Products (extant)





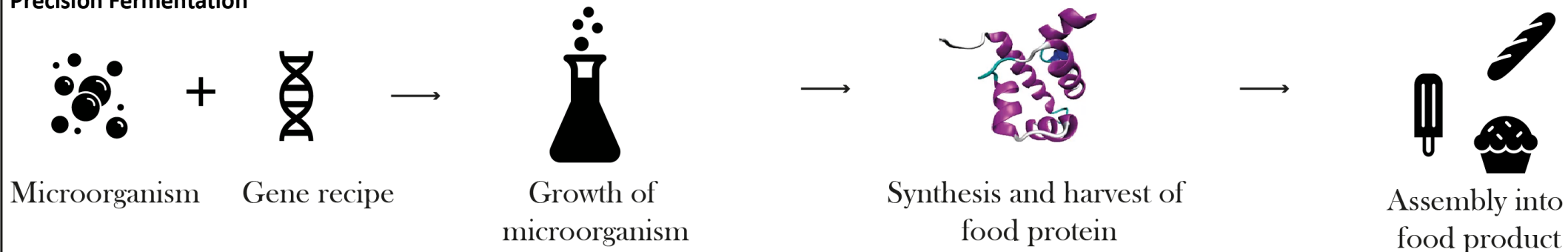
dairy

BY BETH KOWITT

July 8, 2020 3:00 PM GMT+2



Precision Fermentation



Cultured meat

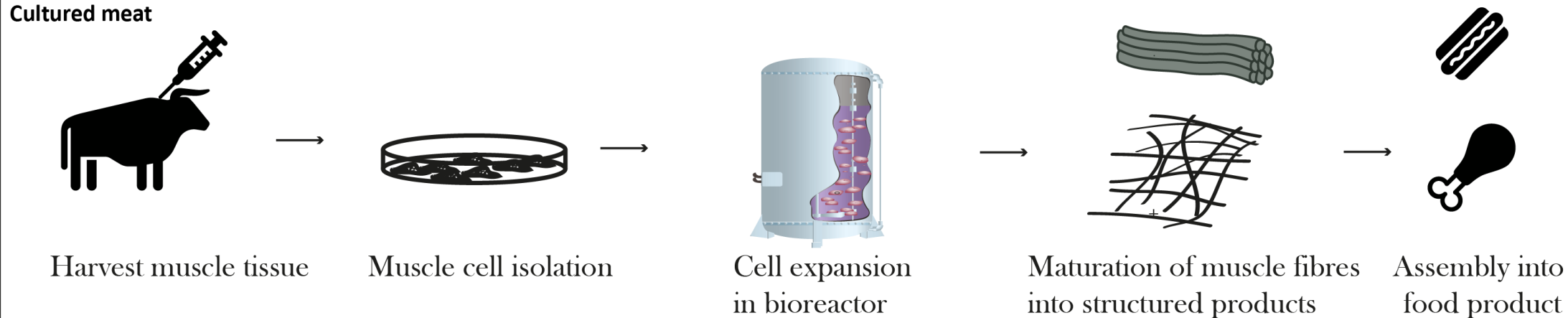


Figure 1: Simplified overview of the two CellAg production systems



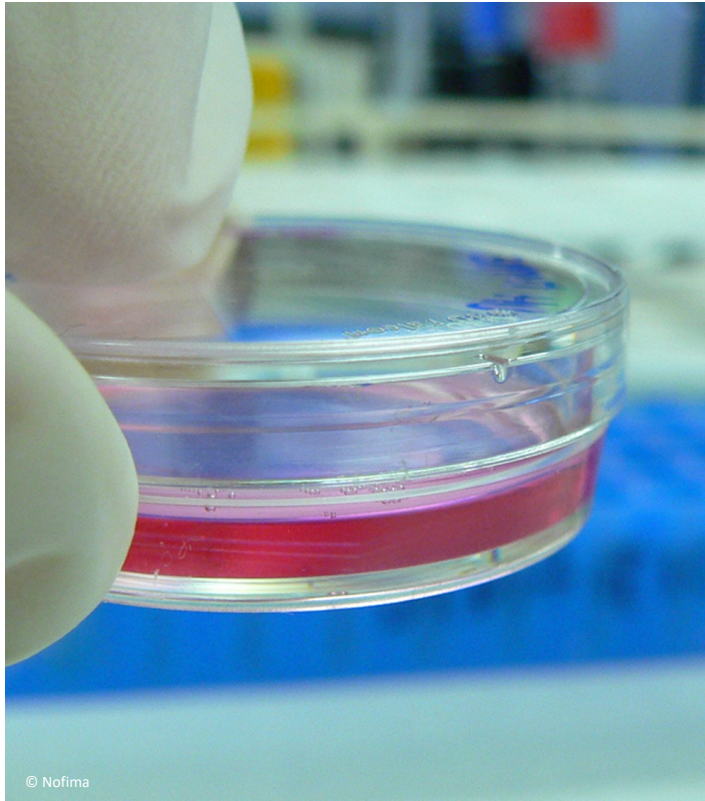
But are we there yet?

Where do the cells come from?

- Bovine, chicken, pig, tuna, salmon, insects, humans, dinosaurs?
- Fat cells, muscle cells, stem cells, gene-modified cells?
- Bacteria, yeast, plants?
- *Picchia*, *Thricoderma*, *Aspergillus*..



Upscaling is a major bottleneck



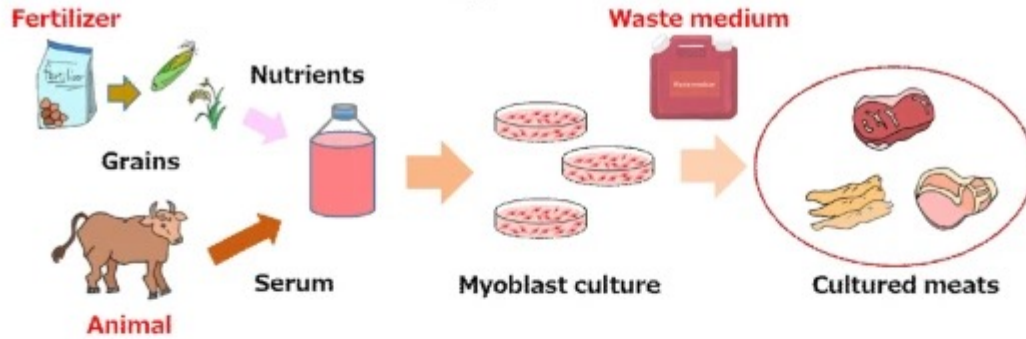
- More Precision fermentation capacity was lost in 2021 than added
- Many of the facilities are old and configured for pharmaceutical or ethanol production
- Only 5% contract fermentation capacity originally for food applications
- Little public or private capital for companies to develop scale-up facilities

What should be the feedstock?

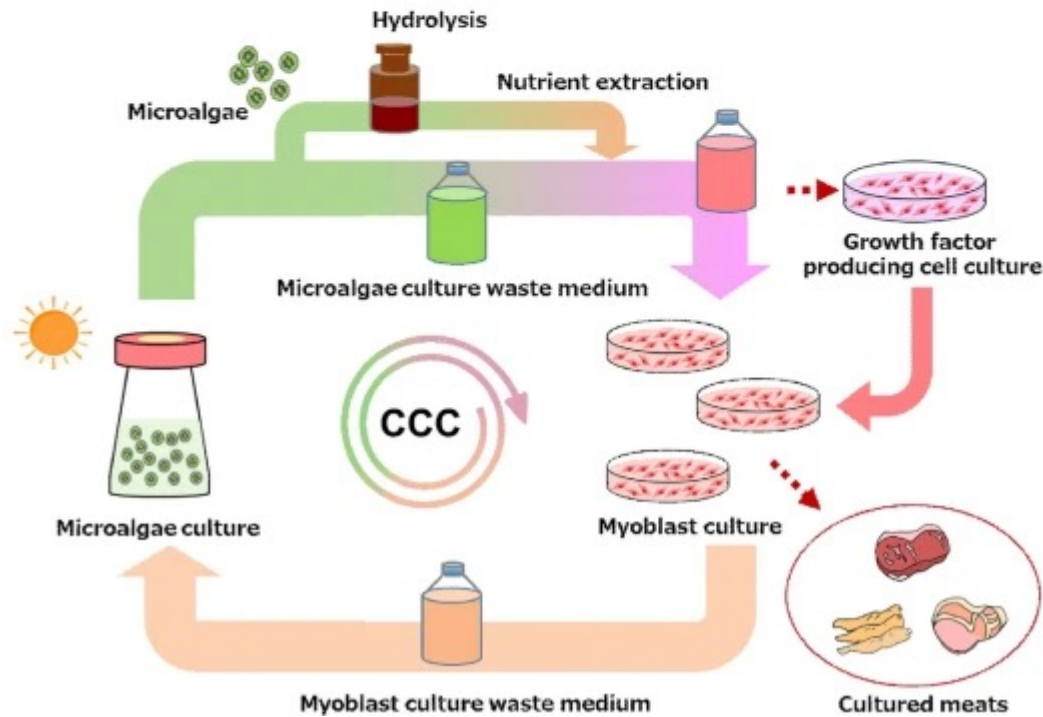


- Feedstock is a major cost driver for most CellAg processes
- The feedstock impacts the output
- The feedstock MUST be sustainable, edible, cheap, specific, general, suitable, available, organic?, natural?, local?...

(a) Conventional cultured meat production



(b) Innovative cultured meat production using circular cell culture (CCC) system



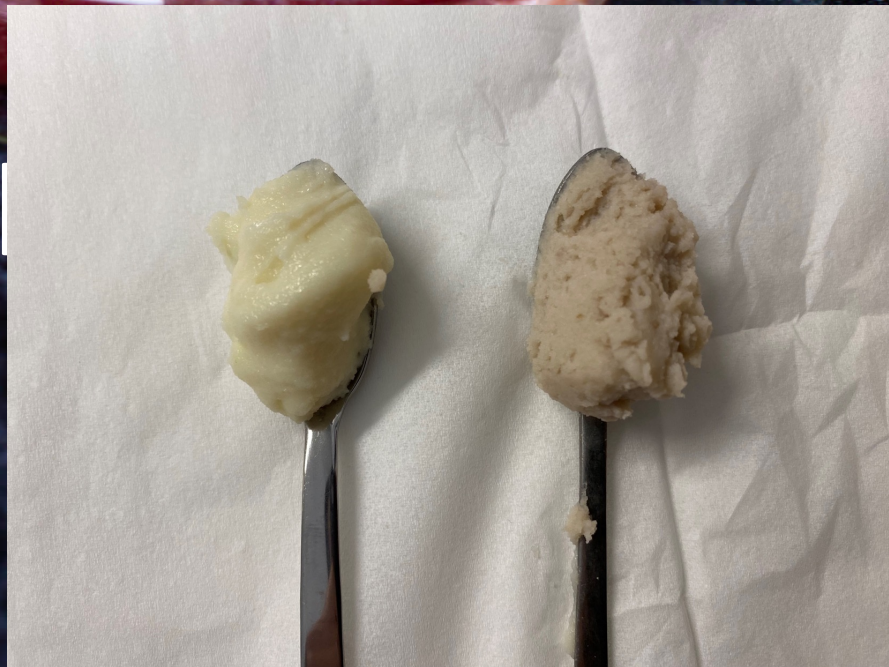
Original Paper | [Published: 12 September 2022](#)

A circular cell culture system using microalgae and mammalian myoblasts for the production of sustainable cultured meat

[Yuji Haraguchi](#) [Yuta Okamoto](#) & [Tatsuya Shimizu](#)

[Archives of Microbiology](#) 204, Article number: 615 (2022) | [Cite this article](#)

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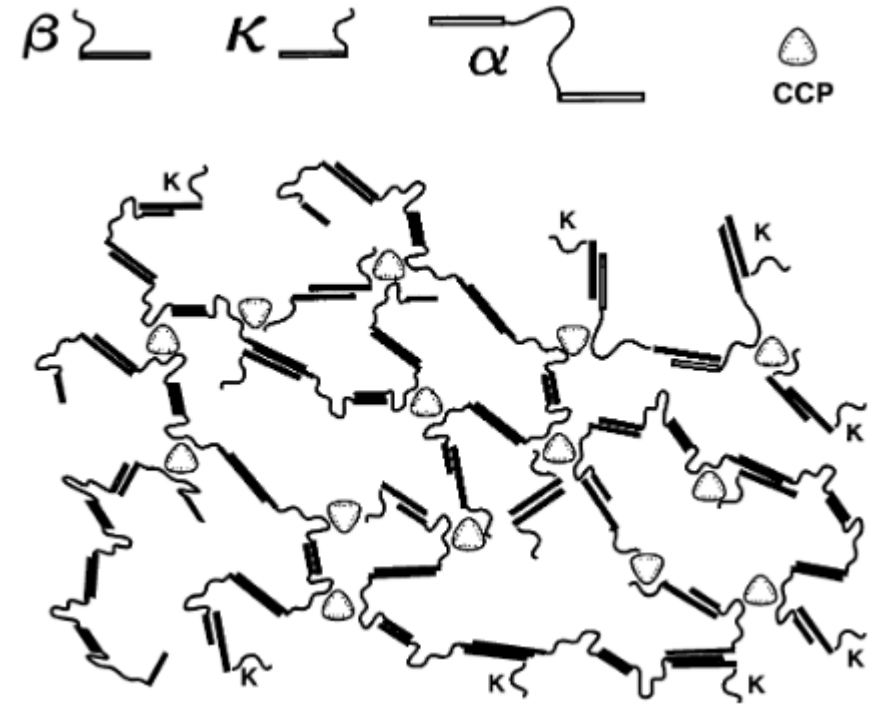
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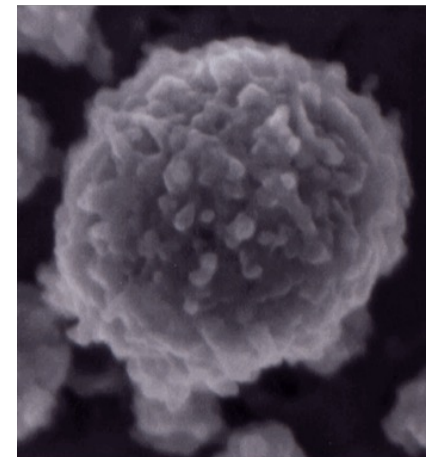
The biggest challenge may be to mimic the vast complexity of food products and unlock the mysteries of why we crave them

Case example: Casein in milk

- Unique to milk-comprise up to 80% of cow milk proteins
- Casein is perhaps the most important protein in milk-give colour
- Important for cheese production
- Contains the 9 essential amino acids perfect for humans, bind calcium and phosphorus required for skeletal growth
- Casein protein consist of α -casein, β -casein, κ -casein
- The casein proteins (together with calcium phosphate clusters) form a complex structure called MICELLE
- The micelles are hard to replicate in fermentation

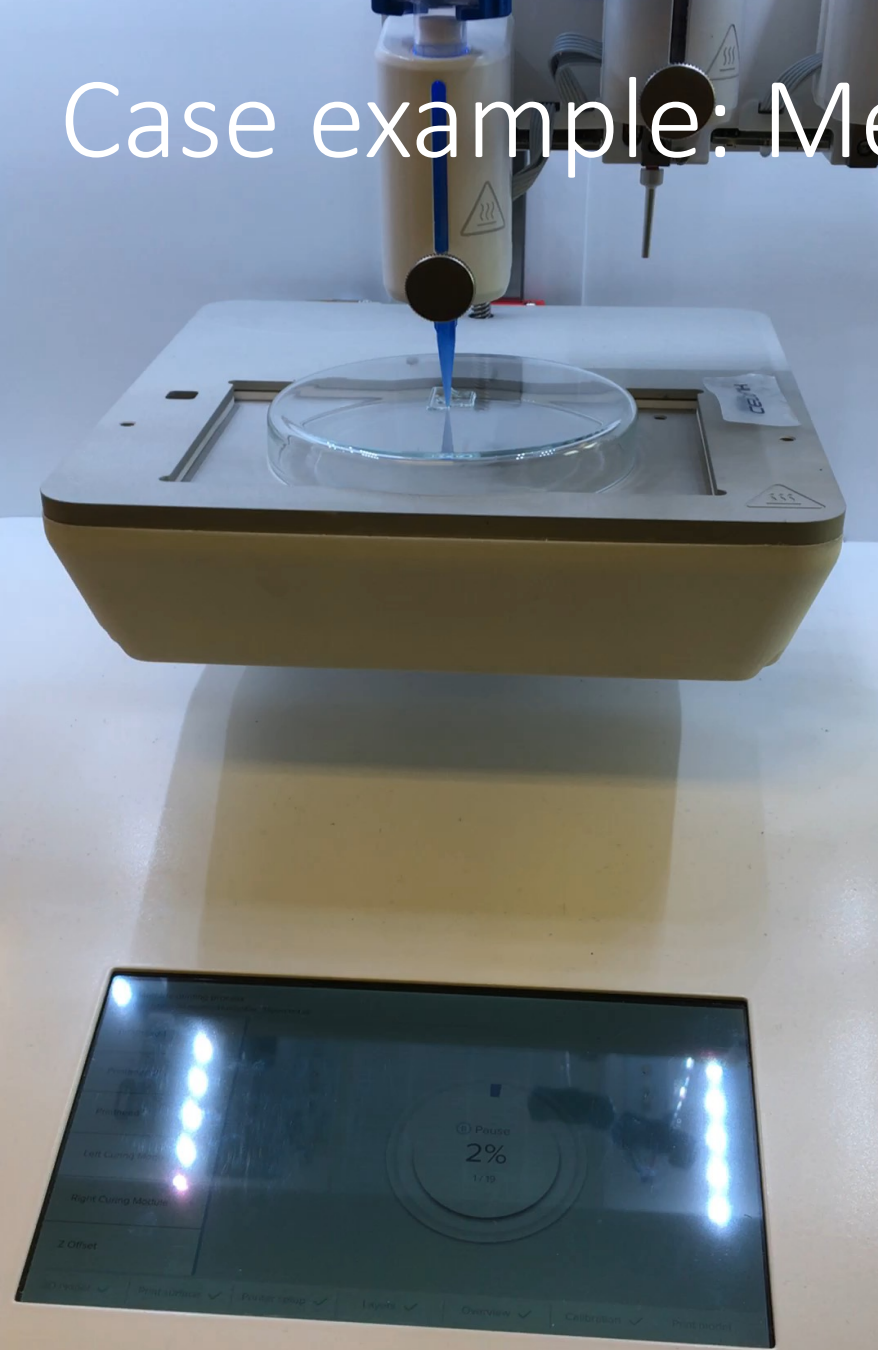


Ref: Horne et al., Int. Dairy Journal 1998



Ref: Dalgliesh et al., Int. Dairy Journal 2004

Case example: Meat



If we succeed....

“1 g of muscle can give 10
000 kg of meat”

The potential is huge



Roasted coffee (left) and coffee cell cultures (right) produced by VTT's cellular agriculture method. Image source: VTT

Israel's Wilk Technologies Earns U.S. Patent Approval For Cultivated Breast and Animal Milk Processes

By Amy Buxton — Published on Feb 14, 2022 — Last updated Mar 23, 2022

ALT PROTEIN ALT DAIRY CELL-BASED NEWS

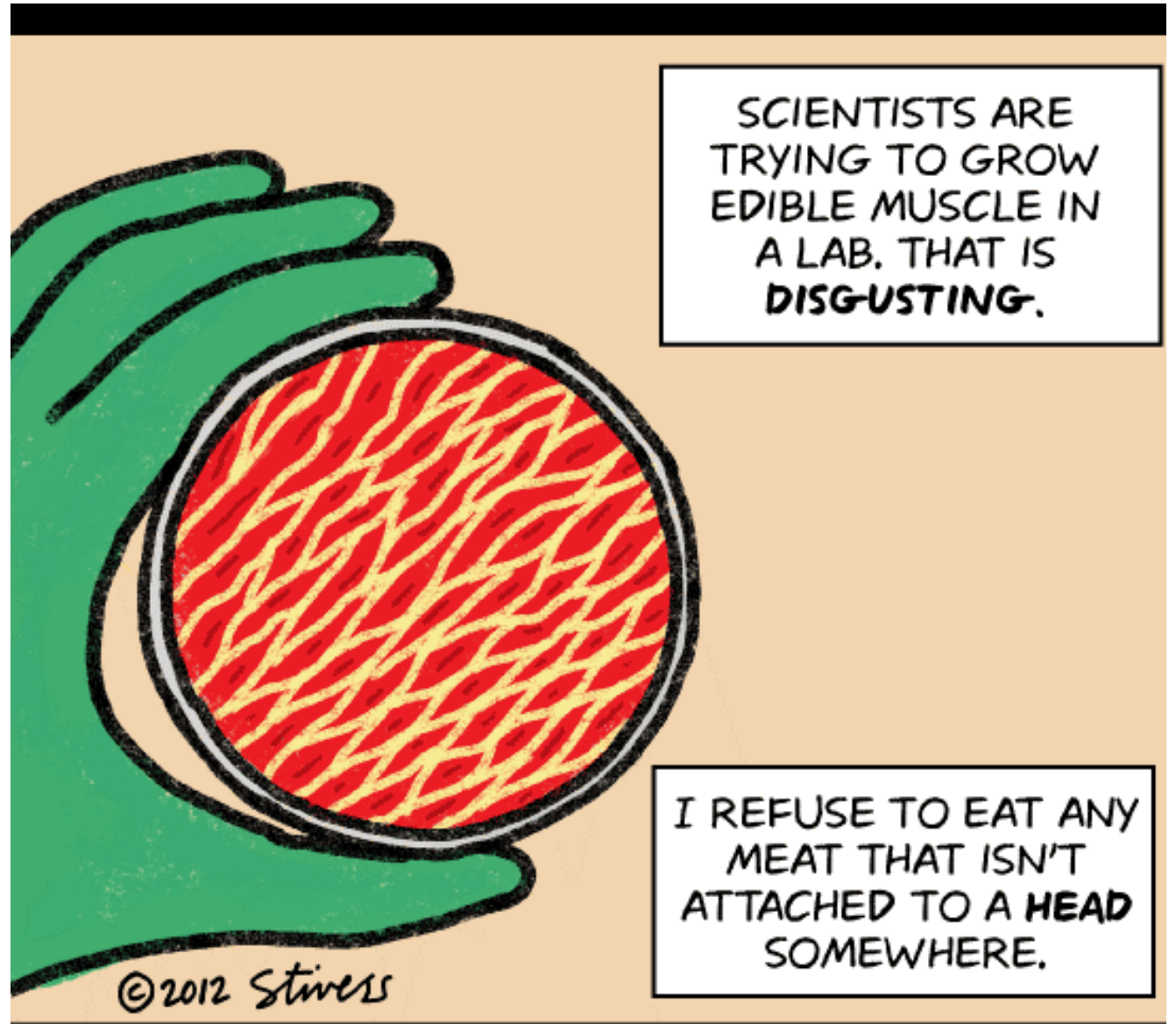


PRODUCT SOURCING | KNOWLEDGE SESSIONS | TASTING BAR



CellAg on the market

- Who should produce this?
- What are the consequences for Norwegian food and aquaculture?
- How to prepare for this?
- Who will eat this?





The food in the future is made in the laboratory



norilia



Thank to my clever colleagues @Nofima

