



Cultivated Meat: An Emerging Novel Food and Industry

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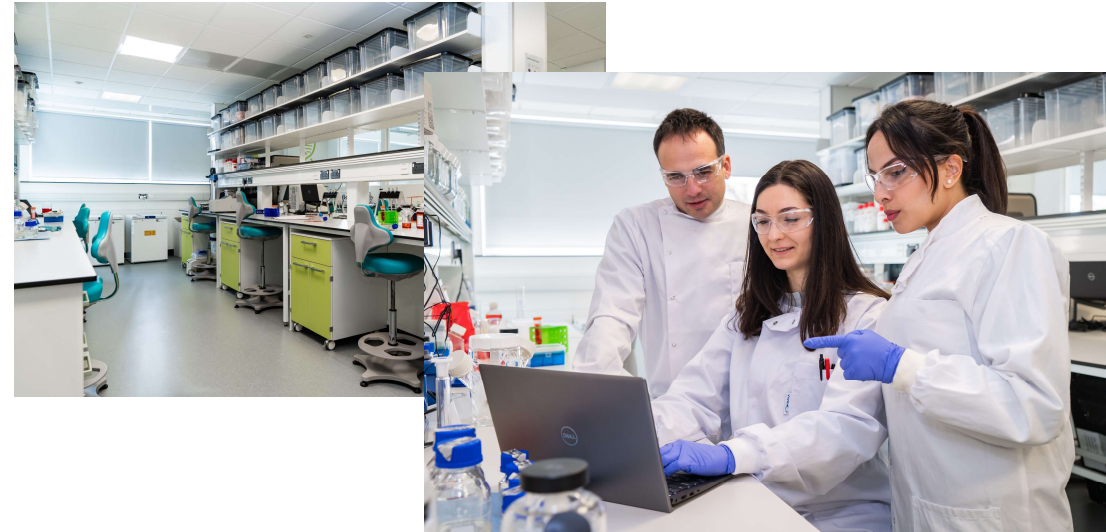


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Who are we and what we do



BioHub, Birmingham Research Park



Ivan Wall
Co-Founder & CEO

Petra Hanga
Co-Founder & CSO

John Sinden
Co-Founder & CTO

Michael Hunt
Co-Founder & Non-Exec Director



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Mission: to accelerate the cultivated meat industry by providing low-cost, food safe, sustainable ingredients and bioprocessing tools.
✓ **reducing costs by 90% with food-safe solutions.**

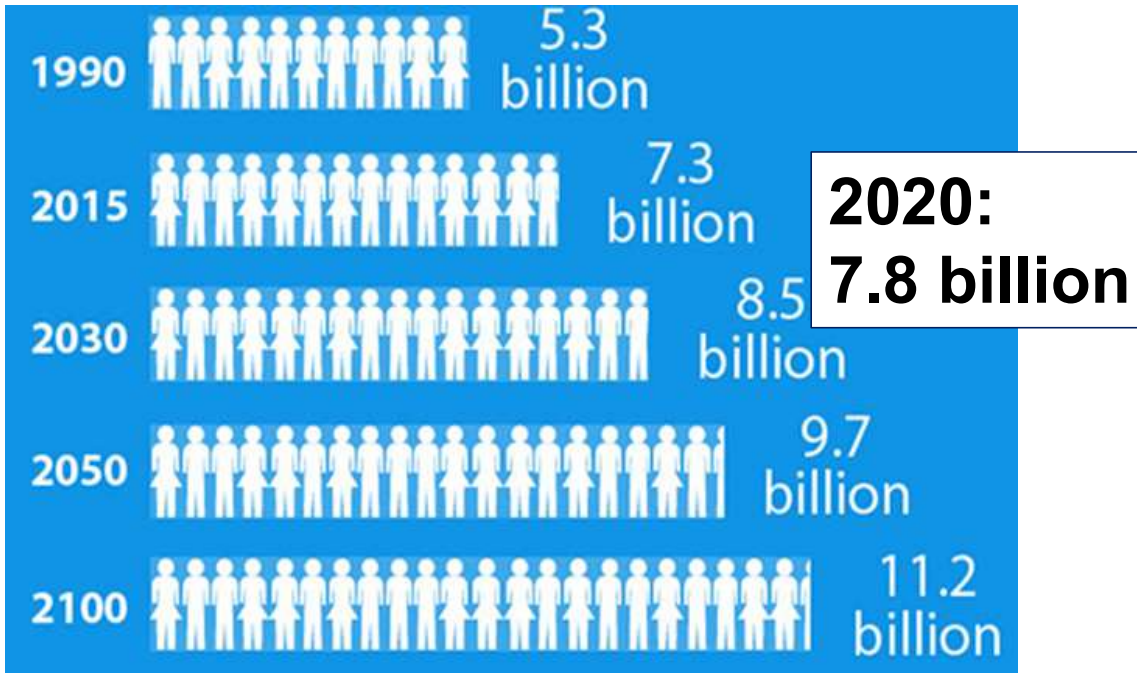
- +70 years in Biotech
- +50 years in cell science
- +50 published papers

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Summary

- Motivation for novel foods
- Introduction to Cellular Agriculture
- What is cultivated meat?
- Cultivated meat industry landscape
- Path-to-market milestones
- GOOD MEAT – green light for safety
- Concluding remarks

Motivation for novel foods (1)



Source: United Nations;
<https://www.un.org/en/sections/issues-depth/population/>

How are we going to feed 10 billion people by 2050?

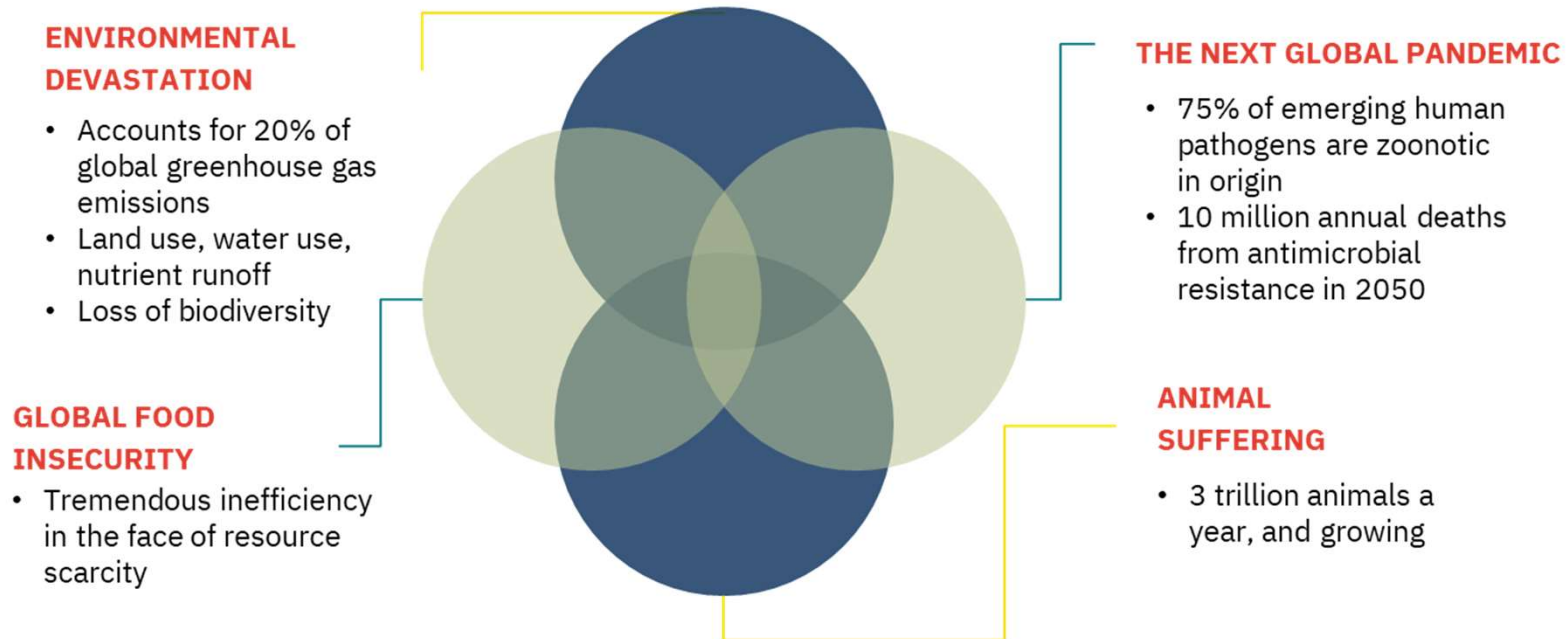
- *TODAY: ~1 in 10 people worldwide are under-nourished
- *PREDICTED: 8% of world's population will face hunger by 2030

*Source: UN - *The State of Food Security and Nutrition in the World (SOFI)*, 2022

Motivation for novel foods (2)

INTENSIVE ANIMAL FARMING

...sits at the intersection of the most pressing issues we face today



*Adapted from GFI

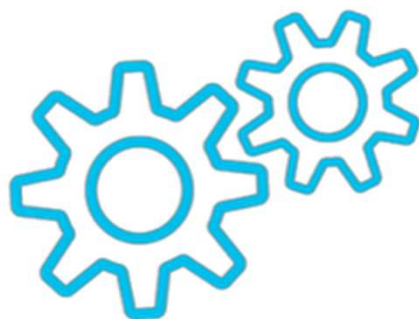
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How are we going to feed 10 billion people by 2050?

- Business as usual is NOT an option
- We need a LONG TERM solution



Sustainably



Efficiently



Safely

Cellular Agriculture

2016: Term 'Cellular Agriculture' – Isha Datar (New Harvest, US)

Definition: Production of animal-sourced foods/materials using cell culture techniques

Examples of products: meat, egg whites, milk, vanilla, silk, leather etc



Source: Datar I, Kim E, d'Origny G: New Harvest: Building the cellular economy. In: B. Donaldson, C. Carter (Eds.), The future of meat without animals. Rowman and Littlefields International, London. 2016; 121–132.

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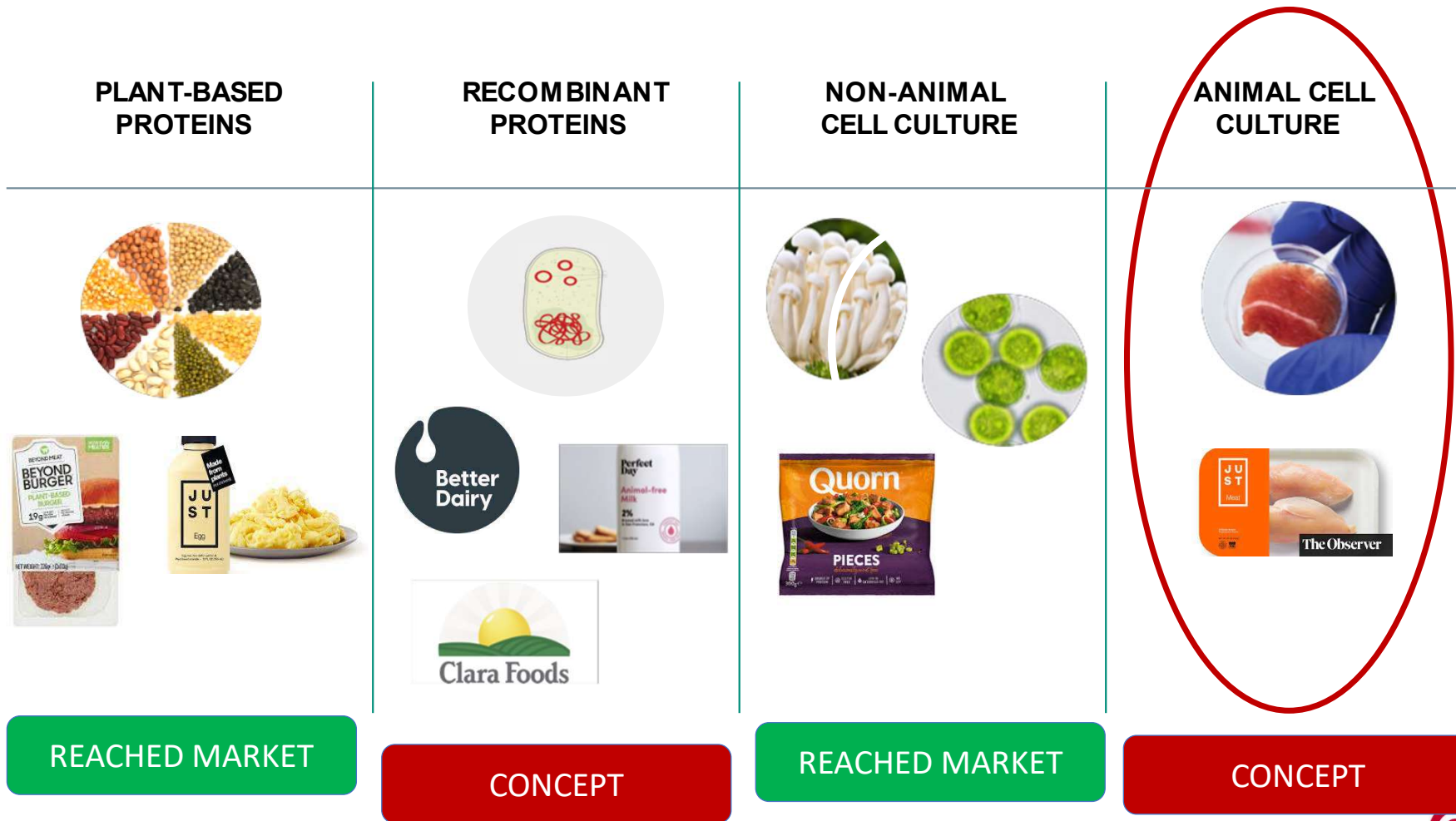
Is this a new concept?



Sir Winston Churchill (1931)

“We shall escape the absurdity of growing a whole chicken in order to eat the breast or wing, by growing these parts separately under a suitable medium”

Classification of cellular agriculture products



Cultivated meat

Cultivated meat (i.e. cell-based meat, cultured meat, clean meat, lab-grown meat)

- Is genuine animal meat.
- It doesn't require animal slaughter.
- It is produced in a **controlled environment** (e.g. bioreactor / cultivator).
- Same **composition** as animal meat.
- Same **taste and nutritional profile** of animal meat.
- It can be **tailored for improved nutrition** (e.g. omega-3-oils, good fats).



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World's firsts

2016 Memphis Meats
↓ World's First Cell-based Meatball



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↑ 2013 Prof Mark Post
World's First Cell-based Burger Patty

→ 2017
FinlessFoods
World's First Cell-based Fish

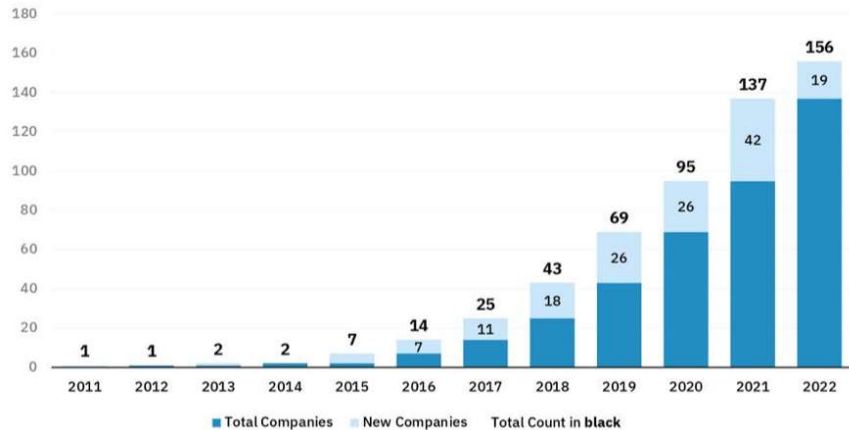


↑ 2019
ShiokMeats
World's First Cell-based Shrimp Dumpling

2020
Higher Steaks
World's First Cell-based Bacon



Current state of the industry



2023:

- 156 cultivated meat companies
 - US: 43
 - UK: 17
 - Israel: 17
 - Singapore: 12
 - Canada: 9
- 26 different countries
- 18 operational facilities for manufacturing cultivated meat and cultivated seafood

*Source: GFI 2022 Cultivated Meat State of the Industry Report

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Path-to-market milestones

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Singapore approves lab-grown 'chicken' meat

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FDA Completes First Pre-Market Consultation for Human Food Made Using Animal Cell Culture Technology

Before Entering the U.S. Market, the Food Must Meet Other Federal Requirements

November 16, 2022



43 Comments

FDA approves lab-grown 'GOOD Meat' chicken product, second such authorization in US

By Fox News

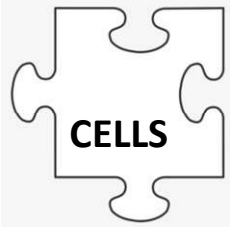
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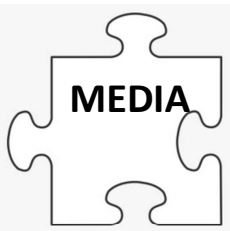
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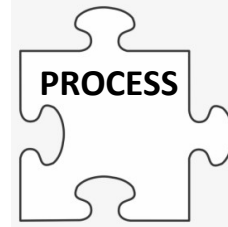
GOOD MEAT– green light for safety (1)



- ✓ Chicken fibroblast line obtained from 10-day old embryonic chicken tissue (DF-1; ATCC)
- ✓ Not engineered or genetically modified
- ✓ Spontaneously immortalised
- ✓ Genetically stable
- ✓ Do NOT form tumours when injected into live chickens



- ✓ Contains foetal bovine serum
- ✓ Doesn't contain any antibiotics
- ✓ Only a trace amount of serum is left after washing the product (~12x lower than that found in milk)



- ✓ Scale: 1000 L
- ✓ No scaffolds used
- ✓ No differentiation step
- ✓ Use a CDMO

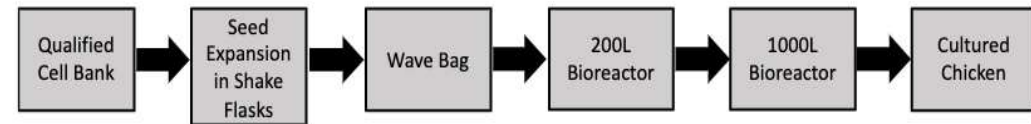


Figure 2. Overview of the manufacturing process for Good Meat cultured chicken.



- Batches of the final product tested and found negative for:
- ✓ Human and avian viruses
 - ✓ Common foodborne contaminants (E. coli, Salmonella)

GOOD MEAT– green light for safety (2)



- ✓ The cultivated chicken cells are intended to be used as an ingredient in a variety of products at 60-75% (w/w).
- ✓ Overall protein and fat content is similar to conventional chicken breast. The high ash content is due to residual salts from salt wash steps.
- ✓ Overall, the amino acid content is reduced compared to traditional chicken breast.
- ✓ The fat content was found broadly in the same range as for traditional chicken breast.
- ✓ No common allergens, including those found in chicken eggs, were expressed in the final product.

Table 48. Nutritional analysis of cultured chicken in comparison with conventional boneless chicken breast. Nutritional values are presented as percentage. Analytes qualified using the nutrition analytical method from Silliker (Crete, IL, USA).

Nutritional package	Chicken breast, dry, raw (USDA, 2012)	Good Meat cultured chicken, dry, raw	Good Meat cultured chicken, dry, raw *
Ash	0	7.6	0
Carbohydrates	0	0	0
Protein	87.1	79.4	86.0
Total Fat	8.2	9.2	10.0

*normalized to 0% ash

Table 49. Percent saturated, monounsaturated and polyunsaturated fats of Good Meat cultured chicken compared to conventional boneless chicken breast. Fat values are presented as % of total fat. Analytes quantified using the nutrition analytical method from Silliker (Crete, IL, USA).

Nutritional package	Chicken breast, dry, raw (USDA, 2012) (% of total fat)	Good Meat cultured chicken, dry, raw (% of total fat)
Fat – Saturated	26.1	31.5
Fat – Monosaturated	34.1	50.0
Fat – Polyunsaturated	17.5	12.0
Calories (<i>per</i> 100g)	49	112



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Concluding remarks

- There is a need for more sustainable approaches to make foods
- Cultivated meat is an exciting concept that could have significant benefits
- Significant milestones achieved in the path-to-market
- Continuous technological advances in the field

THANK YOU FOR YOUR ATTENTION!



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