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PRESENTAZIONE DI
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The European House
Ambrosetti

Cell-based food: claims but uncertainty

What we know? and what we should know?

Jean-François Hocquette

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Marie-Pierre Ellies Oury

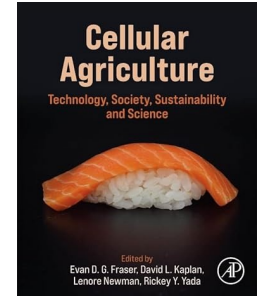
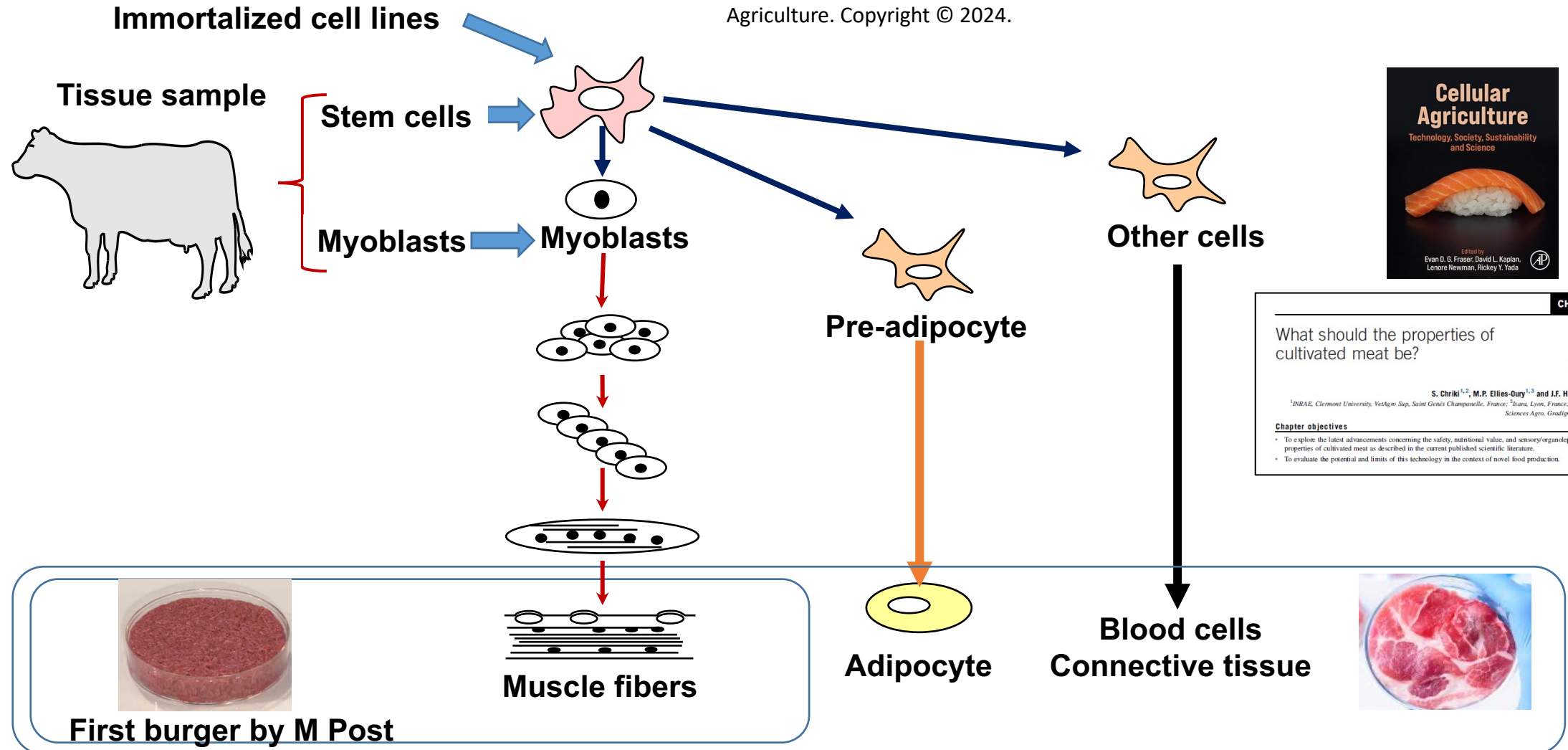
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Status of the technology: principles

Chriki, Ellies-Oury, Hocquette (2023). What should the properties of cultivated meat be? In: Cellular Agriculture. Copyright © 2024.



CHAPTER 5

What should the properties of cultivated meat be?

S. Chriki^{1,2}, M.P. Ellies-Oury^{1,3} and J.F. Hocquette¹

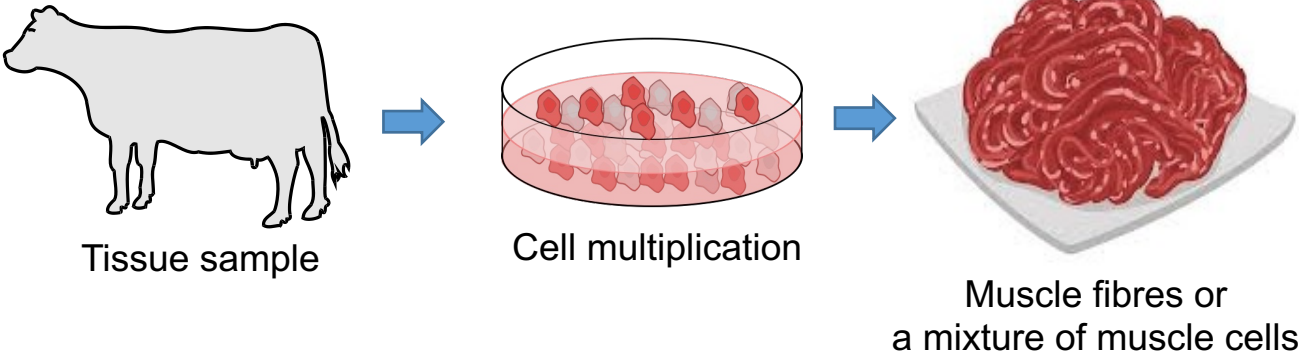
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Chapter objectives

- To explore the latest advancements concerning the safety, nutritional value, and sensory/organoleptic properties of cultivated meat as described in the current published scientific literature.
- To evaluate the potential and limits of this technology in the context of novel food production.

It is not meat on a biological point of view

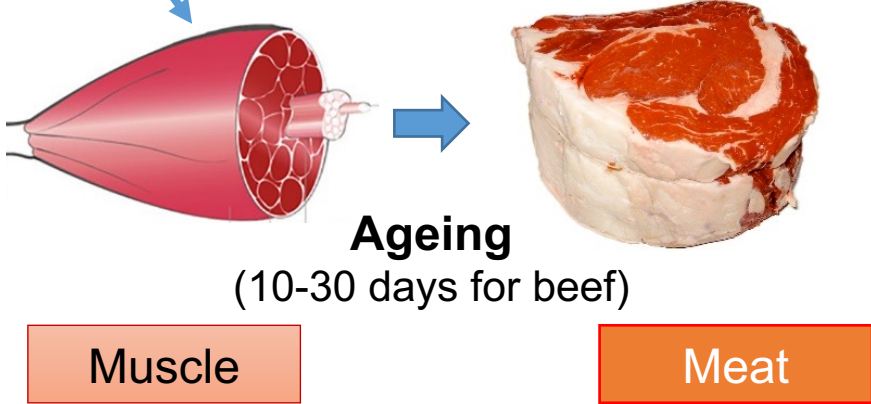
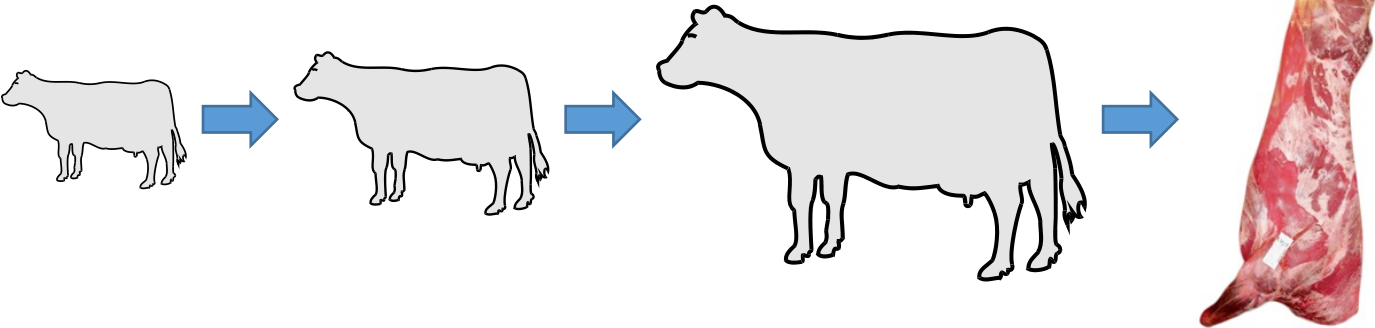
Cell-based food production



Addition of missing nutrients.
No study on digestibility

What about ageing of cultured cells?

Cell multiplication during animal growth



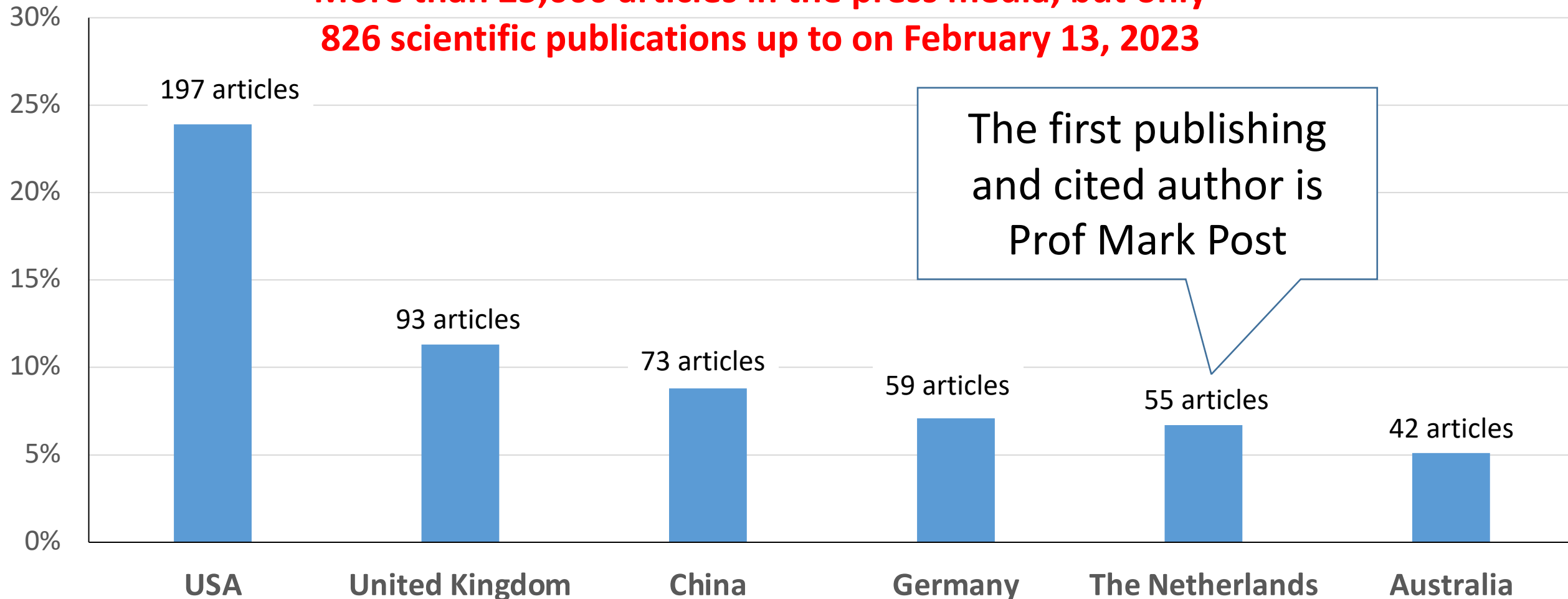
Ageing
(10-30 days for beef)

Chriki et al. (2022). Animal Frontiers, 12, 35-42.
Chriki et al (2023). Cahiers de Nutrition et Di t tique, in press

Cell-based food: revolution or hype?

<https://www.swissinfo.ch/eng/business/cultured-meat--revolution-or-hype--/47892954>

More than 25,000 articles in the press media, but only 826 scientific publications up to on February 13, 2023



There is a consensus about the technical problems to solve

Current limitations across four domains are:

- cell line development,
- cell culture media (fetal bovine serum),
- scaffolding, and
- bioreactors.

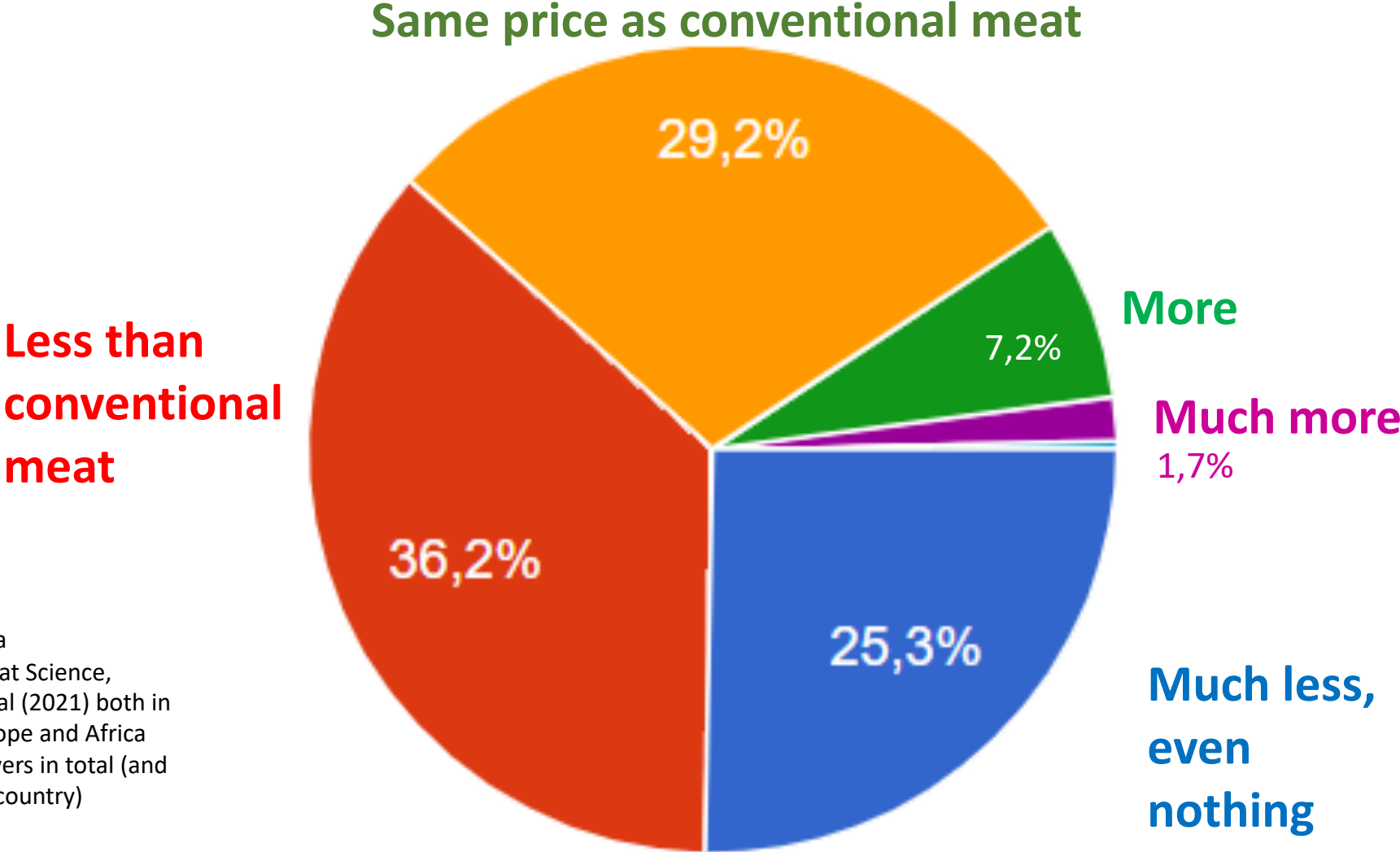
Chen et al. (2022). Biomaterials 280, 121274

The great challenge is to efficiently produce cell-based food products at scale, this needs new concepts and bioprocesses that did not exist before

Bellani et al (2020) Front. Nutr. 7:575146.



Consumers don't want to pay more for cell-based food

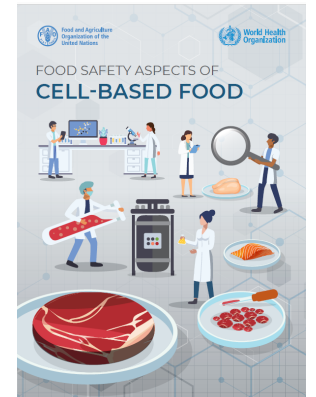
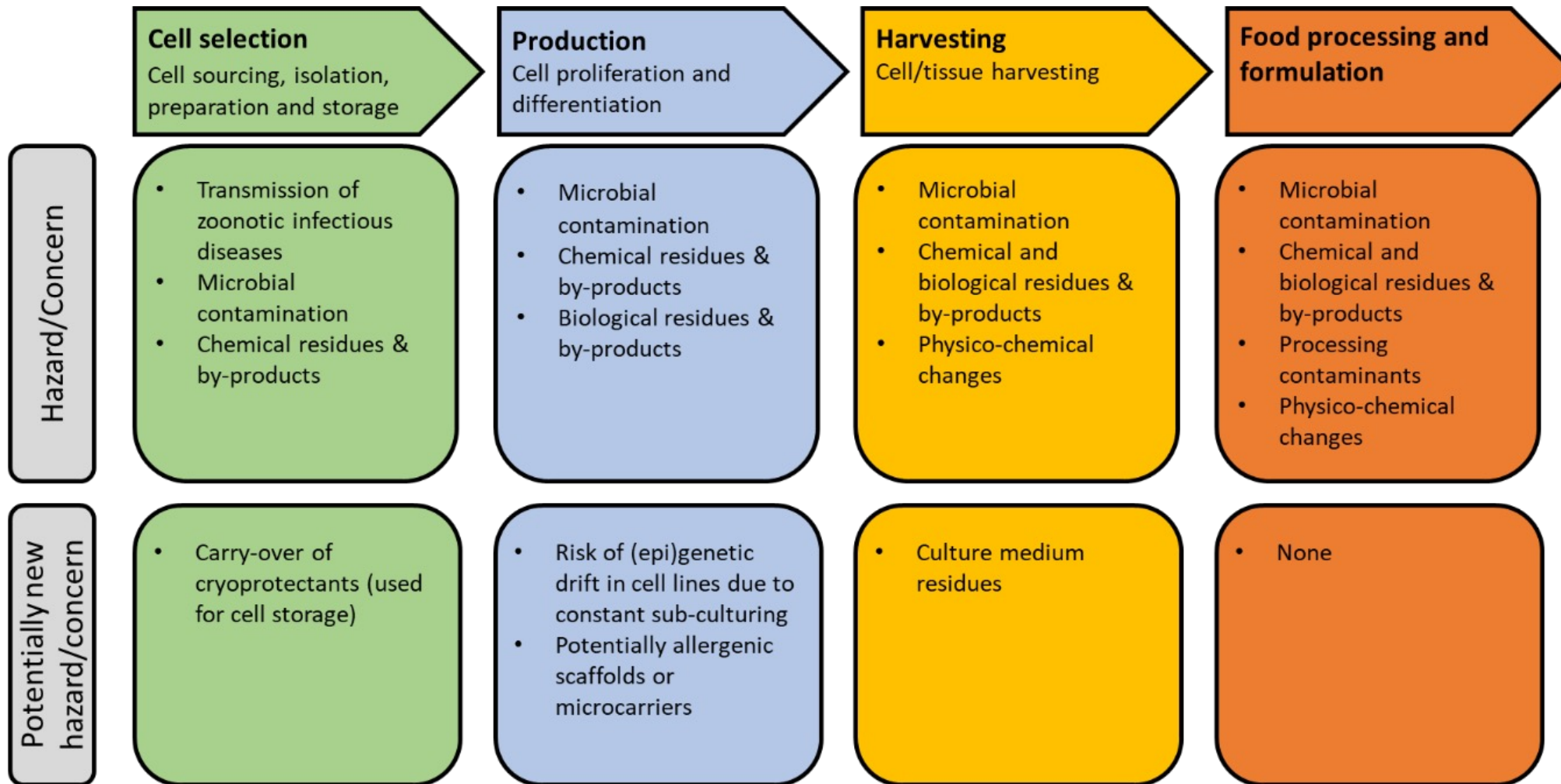


Results in France, Brazil, China
Hocquette et al. (2022) in Meat Science,
Chriki et al. (2021) and Liu et al (2021) both in
Foods. Plus data in South Europe and Africa
Total: more than 15,000 answers in total (and
more than 4,000 answer per country)

Cell-based food safety research priorities (FAO)

Hazard identification based on 4 production phases

“If it isn’t safe, it isn’t food.”



Masami Takeuchi, PhD, Food Safety Officer, FAO, Sept 1st, Lyon
 FAO & WHO. 2023. Food safety aspects of cell-based food. Rome.
<https://doi.org/10.4060/cc4855en>

Is cell-based food healthy?

Cell-based food currently differs significantly from meat in its technological, sensorial and nutritional properties”: it has a pale colour due to the absence of myoglobin” and a low iron content (Fraeye et al., 2020, Frontiers in Nutrition 7:35 and Olenic M, Thorrez L. Cultured meat production: what we know, what we don’t know and what we should know. Ital J Anim Sci 2023;22:749—53, <http://dx.doi.org/10.1080/1828051X.2023.2242702>).

Nutrition Profile	Soy base	Cultured chicken	Chicken breast
Energy (kcal 100 g ⁻¹)	157.0	137.0	106.0
Protein (g 100 g ⁻¹)	22.5	19.1	19.8
Fat by hydrolysis (g 100 g ⁻¹)	4.7	4.5	2.9
Saturated fat (g 100 g ⁻¹)	0.4	0.7	0.9
Cholesterol (mg 100 g ⁻¹)	0.0	56.9	89.8
Carbohydrates (g 100 g ⁻¹)	1.0	0.8	0.1
Sodium (mg 100 g ⁻¹)	399.0	346.2	157.0
Ash for minerals (g 100 g ⁻¹)	1.0	0.9	1.2

Cell-based food has been analysed once

- Same protein content,
- The vitamins, minerals and amino acid profile are comparable.
- Lower in saturated fat and cholesterol
- But higher in sodium

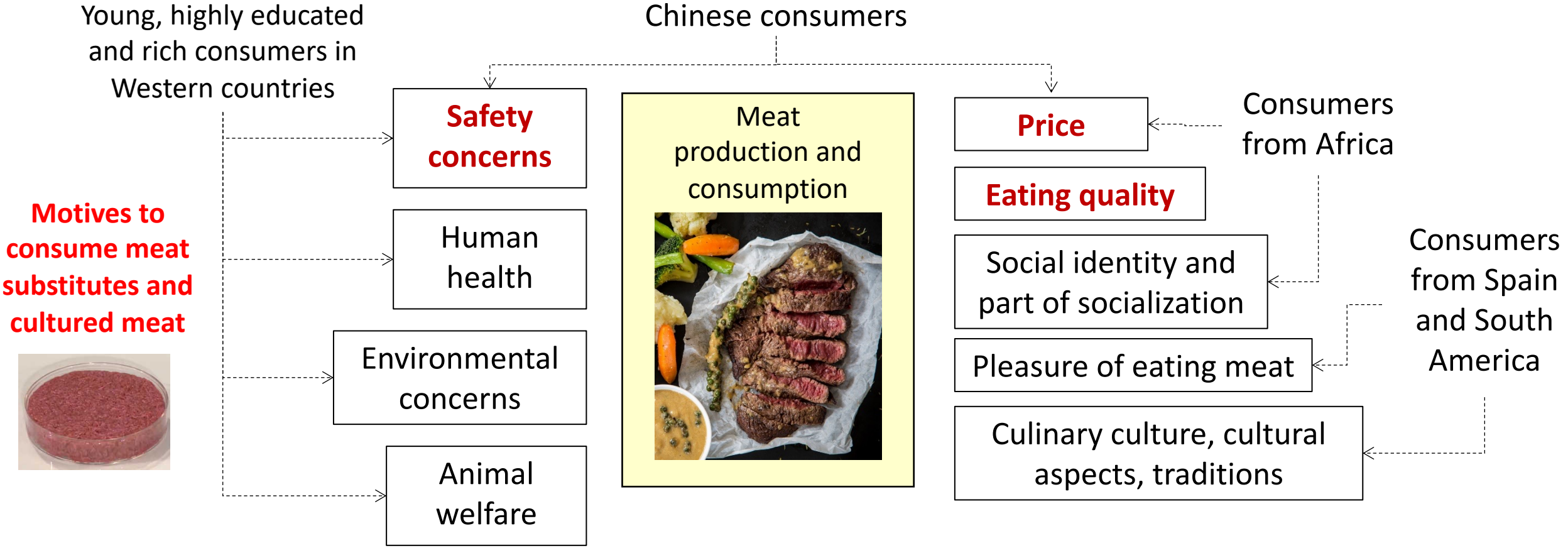
Status of regulation worldwide (EU, USA)

If no genetic modification is involved, the approval by the European Commission on the advice of the European Food Safety Authority (EFSA) under **Novel Foods Regulation** is required before “cultured meat” can be marketed in Europe.

The purpose of this regulation is to ensure that novel foods are safe to eat, and this has not been fully demonstrated at this stage for all cultivated food products *[Chriki et al. (2022). Animal Frontiers, 12, 35-42]*

In addition to Singapore, early 2023, **the USDA granted approval for Upside Foods and Good Meat to sell their lab-grown cell-cultivated chicken products in the United States.**

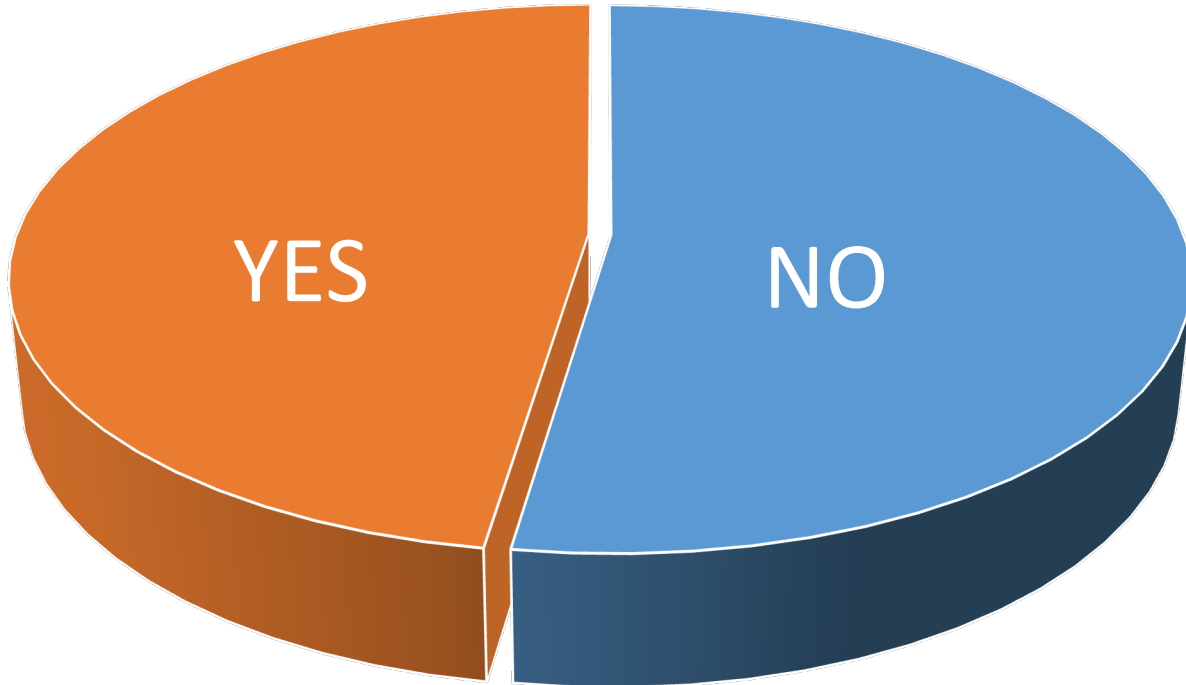
Motives and barriers of consumption of meat and meat substitutes



Interaction with affective factors, personal compromise between barriers and motives, meat origin, livestock systems, etc

From a special issue of Meat Science (with 24 papers)
 Meat Science 200 (2023) 109163

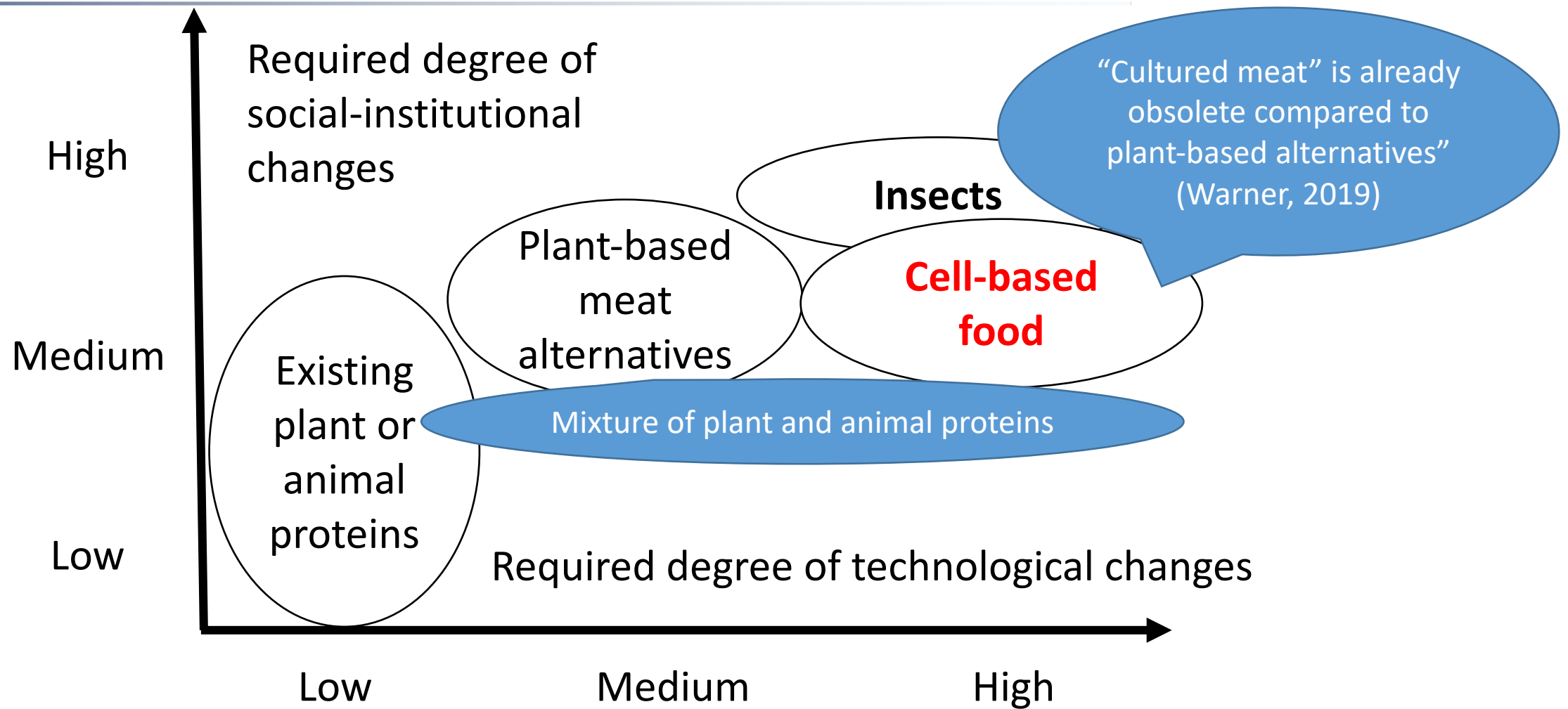
Is it really meat according to consumers?



Average of more than 10,000 answers from Brazil (Chriki et al., 2021. *Foods*, 10,11, 2588 <https://doi.org/10.3390/foods10112588>), European and American countries (unpublished results)

Reminder: the product should be properly labelled, so as not to mislead consumers (EU regulation)

The required degree of changes is a driver of food acceptance



Van der Weele C, Feindt P, Jan van der Goot A, van Mierlo B, van Boekel M. Trends Food Sci Technol. (2019). 88:505–12.

Warner (2019). Animal, 13, 12, 3041-3058. <https://doi.org/10.1017/S1751731119001897>

Environmental impacts are not known

Overview of the main gaps identified in each study related to environmental impacts of Cell-based food

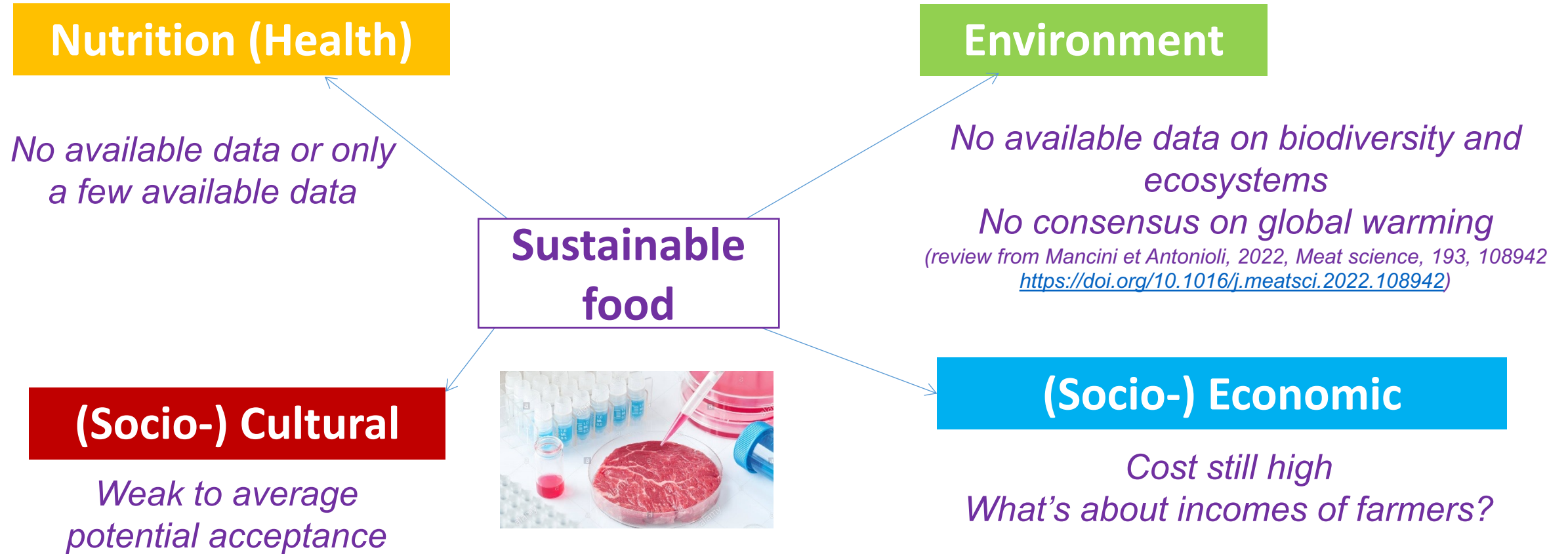
	Tuomisto and Teixeira de Mattos (2011)	Tuomisto et al. (2014)	Smetana et al. (2015)	Mattick et al. (2015)
Cell collection	—	—	—	—
Growth factors production	—	—	—	—
Scaffold production	—	—	—	+
Bioreactor's production	+	+	+	+
Cleaning bioreactor	—	—	—	+
Culture media recycling	—	—	—	—
Scaffold removal/recovery	—	—	—	—
Wastewater treatment	—	—	—	—

Rodríguez Escobar et al. (2021). Foods 2021, 10, 2941. <https://doi.org/10.3390/foods10122941>

Cell-based food production is energy-intensive

(Sinke et al., 2023. The International Journal of Life Cycle Assessment volume 28, pages 234–254 <https://doi.org/10.1007/s11367-022-02128-8>)

“Cultured meat” cannot contribute to a sustainable diet



Definition of sustainable food is from FAO (FAO, WHO, 2019. Sustainable healthy diets -Guiding principles. Rome - Italy)
<http://www.fao.org/3/ca6640en/CA6640EN.pdf>