

# Limitations and challenges for the successful launch to market of cultured animal protein products

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A preliminary analysis for an R&D project on the **production of cultivated meat from pig breeds of a Protected Geographical Indication.**

# Cultivated Meat Process: The State of the Art

## Cultivated meat process



### Input

Stem cells are acquired and banked from an animal.



### Proliferation

Cells are grown in bioreactors at high densities and volumes.



### Differentiation

Cell differentiation and maturation are induced by changing the culture conditions.



### Food

Differentiated cells are harvested, prepared, and packaged into final food products.

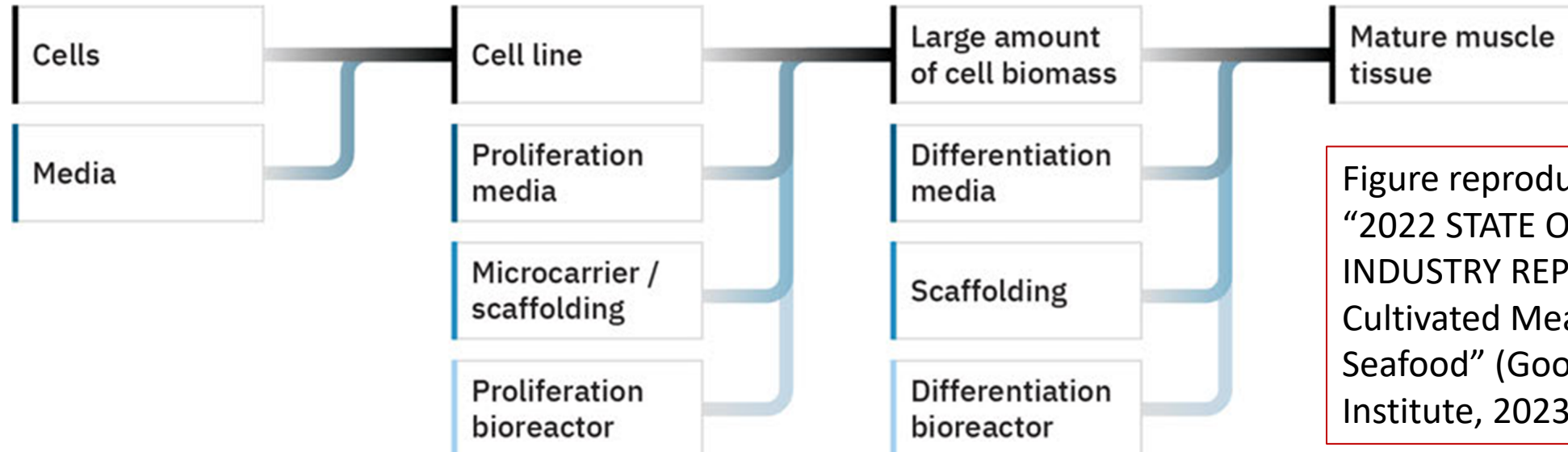


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“2022 STATE OF THE  
INDUSTRY REPORT:  
Cultivated Meat and  
Seafood” (Good Food  
Institute, 2023).



# Technological Limitations and Challenges

- 1) **Immortalized cell lines vs non-immortalized cells lines:** From the **primary cell lines** obtained from biopsies (usually satellite cells of skeletal muscle tissue), **immortalized secondary lines** are usually obtained. Immortalization can be **spontaneous or carried out by genetic modification** (i.e. CRISPR cas9).

**POSSIBLE SOLUTION:** For our R&D project, we consider that the best option is **spontaneous immortalization of porcine fibroblasts lines**.

- 2) **Three-dimensional growth of cell cultures on scaffolds vs three-dimensional growth in suspension:** The culture media and scaffolds produced by the pharmaceutical industry for the three-dimensional growth of cell lines in order to obtain organoids for biomedical research are currently very expensive, most include products of animal origin such as fetal bovine serum (FBS).

**POSSIBLE SOLUTION:** Specialized startups and companies are developing serum-free culture media and eatable microcarriers and scaffolds that can be used for **three-dimensional growth in suspension**.



# Technological Limitations and Challenges

3) **Serum-free cell culture media and growth factors:** Cell culture media supply the nutrients and growth factors needed to cultivate cells outside the body. As a key input into the cultivated meat process, it is currently **the largest variable cost of cultivated meat production**. Formulation of cell culture media remains a challenge because each medium formulation will need to be **adapted to the needs of the species and cell type being cultivated**. Likewise, **growth factors** are currently the **highest cost ingredient within cell culture media**.

**POSSIBLE SOLUTION:** Collaboration with emerging suppliers of **more affordable and sustainable animal-free culture media and growth factors** for jointly developing them **customized to the specific needs of the species and cell types to be cultivated**.



# Technological Limitations and Challenges

- 4) **Development of cultivated animal protein and fat products:** Although it is also possible to co-culture multiple types of cells together to develop a 3D meat-like structure, separately **culturing previously immortalised muscle and fat tissue cells in bioreactors with custom-designed culture media and growth factors** can allow for greater effectiveness and efficiency.

**POSSIBLE SOLUTION:** Our choice is **cultivating separately immortalized muscle and fat tissue cells** in proliferation bioreactors without the need of using differentiation bioreactors with scaffolds embedded.

- 5) **Bioreactors design and size:** Some of the main American startups are designing production systems with large bioreactors of more than 10,000 L. When working with cell cultures, as the size of the bioreactor increases, **the performance of bioreactors starts to be affected by problems related to the agitation levels necessary for an adequate distribution of gases in the fluid**. Likewise, too high production capacities could induce, rather than the supposed economies of scale, **overproduction and large inventories with high energy consumption**, high food waste and very high fixed costs that made difficult to reach break-even levels.

**POSSIBLE SOLUTION:** Using relatively small bioreactors (500 or 1,000 L) in highly digitized and controlled production environments adopting a Lean & Green approach.

# Socio-economic and Environmental Limitations and Challenges



- 6) **Cultivated meat vs hybrids of plant-based protein and cultivated animal protein and fat:** While the price of conventional meat products such burgers is around 10 euros per kg (average), a recent study has estimated that **the total cost of 1 kg of cultivated meat could be as high as \$63/kg** when it is produced in a large-scale facility, That is why one of the main challenges presented by this new technology is the price of the final product

**POSSIBLE SOLUTION:** In this context, the price of **hybrids of cultured animal protein and plant-based protein** could be closer to the prices of conventional meat products.

- 7) **Financial limitations and business model:** Financial constraints can be a major barrier to the development of cultivated meat products. **The Silicon Valley investment model aims to create large global oligopolies** by investing huge amounts of capital to reach very high production capacities and intensive use of intellectually protected technologies.

**POSSIBLE SOLUTION:** A business model based on production levels designed for **satisfying the needs and expectations (determined by market research studies) of specific segments in local (national) markets**. It could be easily replicated in different counties of the EU by using, for instance, high sustainability franchises.

# Socio-economic and Environmental Limitations and Challenges



8) **Sustainability and transparency in the value chain:** A recent analysis for individual gas emissions ( $\text{CO}_2$ ,  $\text{CH}_4$ , and  $\text{N}_2\text{O}$ ), rather than relying on carbon dioxide equivalent ( $\text{CO}_2\text{e}$ ) metrics, indicates that cultivated meat is not a priori climatically superior to cattle; its relative impact instead depends on the availability of decarbonized energy generation and the specific production systems that are implemented. **Cultured meat greenhouse emissions are almost entirely  $\text{CO}_2$  from energy generation.** For this reason, it is critical to design low carbon production systems and value chains for the commercial production and delivery of cultured meat.

**POSSIBLE SOLUTION:** The intensive use of photovoltaic and photothermal energy sources together with a 100 % renewable energy supply is crucial for getting substantial reductions in the carbon footprint of the cultivated meat products . The continuous improvement of energy efficiency based on Industry 4.0 and Lean & Green approaches could also play a relevant role. **Continuous monitoring systems for the food waste and for the energy, carbon, and water footprints**, combined with independent third-party sustainability certification schemes could contribute to a greater transparency in the value chain.

# Socio-economic and Environmental Limitations and Challenges



- 9) **Consumers' acceptance and willingness to pay:** A recent market research study on the willingness to pay for cultivated meat burgers in comparison with conventional meat burgers with representative samples of consumers from France, Spain, and United Kingdom has shown that **younger consumers with a lower degree of neophobia towards new food technologies tend to be more accepting of cultured beef**. In each of the three countries, a segment of consumers was identified who were **willing to pay a higher price (a premium) for the cultured beef burger**. Thus, the UK has the largest segment of consumers (47%) willing to pay a premium of £5.10/kg for cultured beef, followed by Spain (38% and €3.35/kg) and then France (30% and €2.68/kg).

**POSSIBLE SOLUTION:** Systematic market **research both with hypothetical studies and with studies where consumers can compare samples of cultivated meat products with conventional meat or plant-based protein products** should play a key role in the new product development processes. Without reliable information about the willingness to pay and the preferences of target market segments is very difficult to have success in the launching of products new to market as the cultivated meat.



# Conclusions

- In this preliminary analysis, the major limitations and challenges for a successful launching to market of **hybrids of cultivated pork protein and fat ingredients and plant-based ingredients** have been identified.
- For facing these limitations and challenges, different solutions have been proposed.
- Some of these solutions differ of the approaches adopted by the major cultivated meat startups in United States, Israel, the Netherlands, Spain, and France.
- These solutions will be tested in a two-years R&D project financed by a grant of the Spanish government (pending to get confirmation).