

# A NOVEL APPROACH TO DEVELOP CULTURED MEAT: DESIGN AND SIMULATION OF A LARGE-SCALE PRODUCTION PLANT

## Part I: Introduction and Theoretical Principles

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### INTRODUCTION

The exponential rise of the global population has led to an important increase of **livestock consumption**, leading to more greenhouse emission, land use and water usage. For instance, in 2018, 274 m<sup>2</sup> of land were needed to generate 1 kg of beef. These, together with the uprising concerns on **animal welfare** are encouraging the scientific community and organizations to rethink our traditional forms of food production.

One of the fundamental strategies that has recently arisen to tackle the unbalances of traditional livestock production is the **cell-cultured meat alternative**. Our proposal, framed in this strategy, is to develop an alternative approach for the production of bovine meat using satellite cells. These cells will be cultured in **stirred tank bioreactors** attached to microcarriers and will be subjected, first, to a proliferation process followed by a differentiation, resulting in product organoleptically resembling meat.

### OBJECTIVES



The aim of this project is to cover a **1%** of the current meat substitute market in **Amsterdam**.

To accomplish this goal, the target production will be of **7 metric tons** of cultured meat per year.

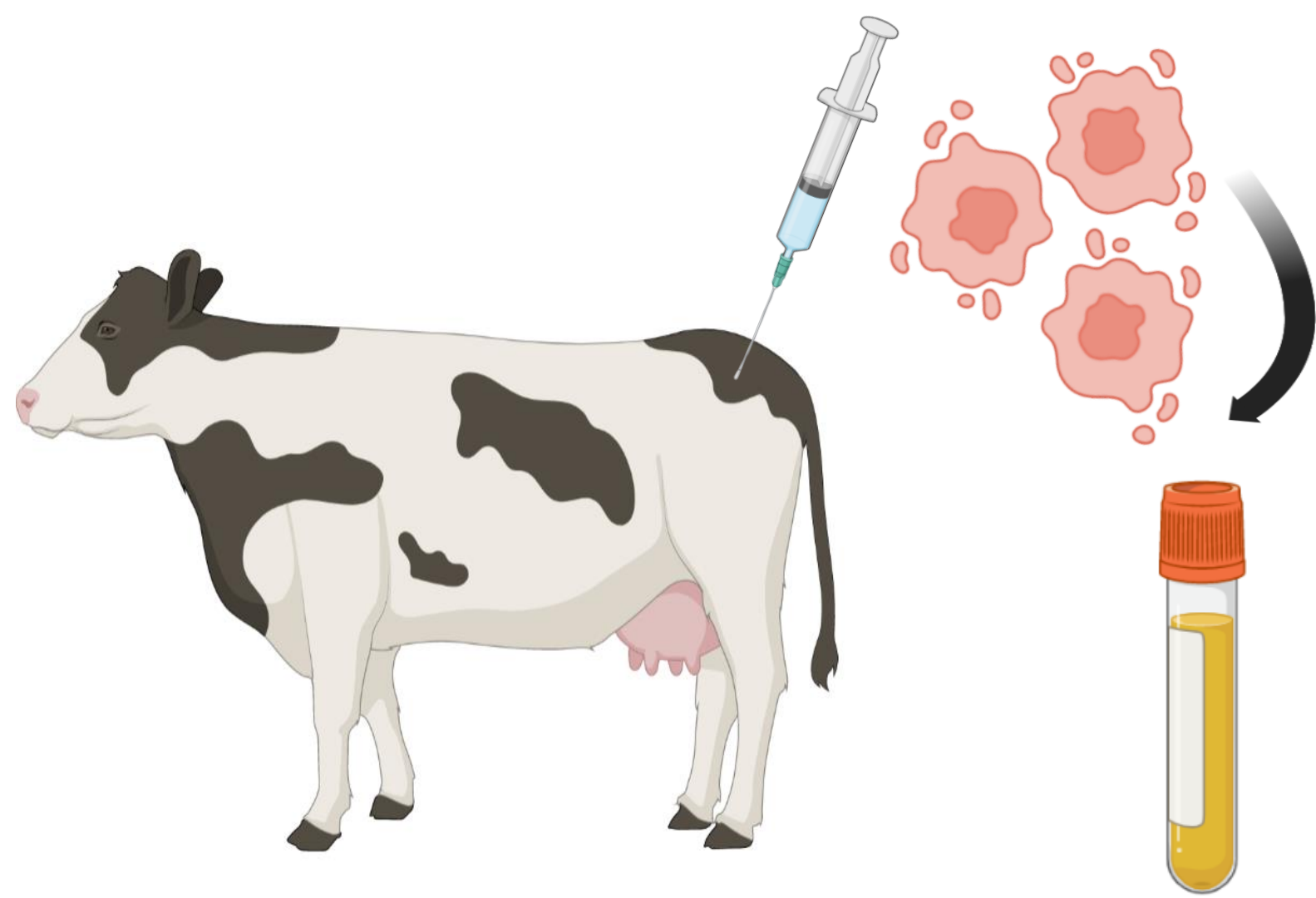
### THEORETICAL PRINCIPLES

#### Cell line

Beef has been chosen for its environmental impact as it has the greatest water consumption and the second greatest land use per kilogram of meat.

##### Bovine satellite cells

- Broadly preferred over embryonic or pluripotent stem cells for an easier isolation → small biopsy under local anaesthesia.
- Widely studied.
- Activation required → growth factors.



#### Proliferation

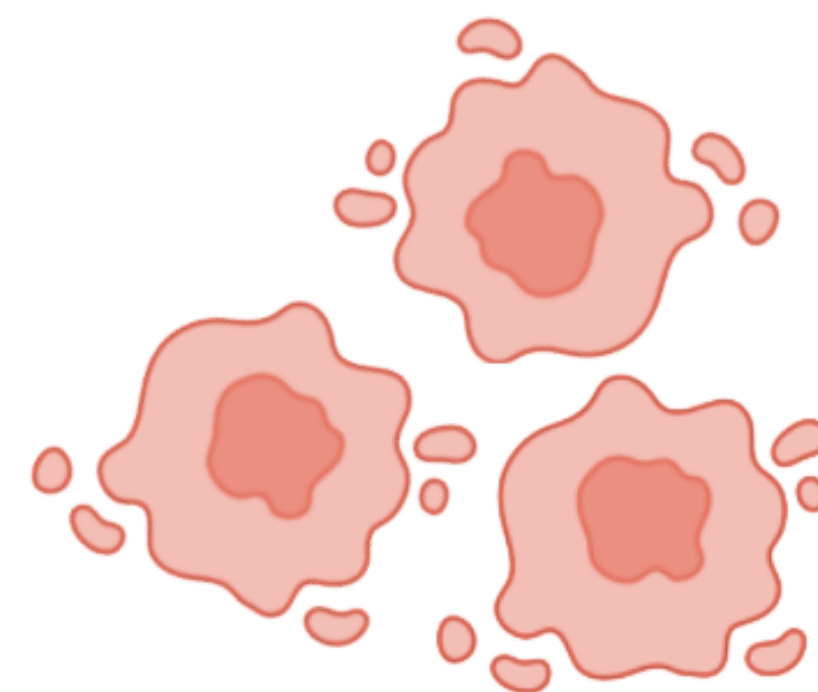
Proliferation is the stage of the process in which cells are grown until the required cell density is achieved.

##### Basal medium

→ **DMEM/F-12**

##### Proliferation medium

- Insulin → **Zinc sulphate**
- Albumin → **α-cyclodextrin**
- TGF-β
- bFGF



#### Differentiation

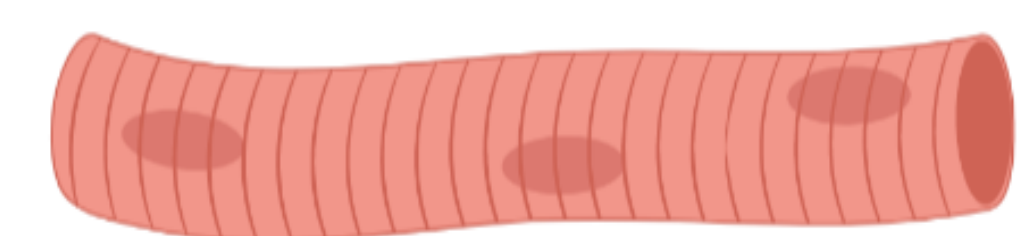
Differentiation of the satellite cells will be considered as the fusion of the mononucleated (classical) cells into multinucleated fibres, phenotype that most resembles regular meat.

##### Basal medium

→ **DMEM/F-12**

##### Differentiation medium

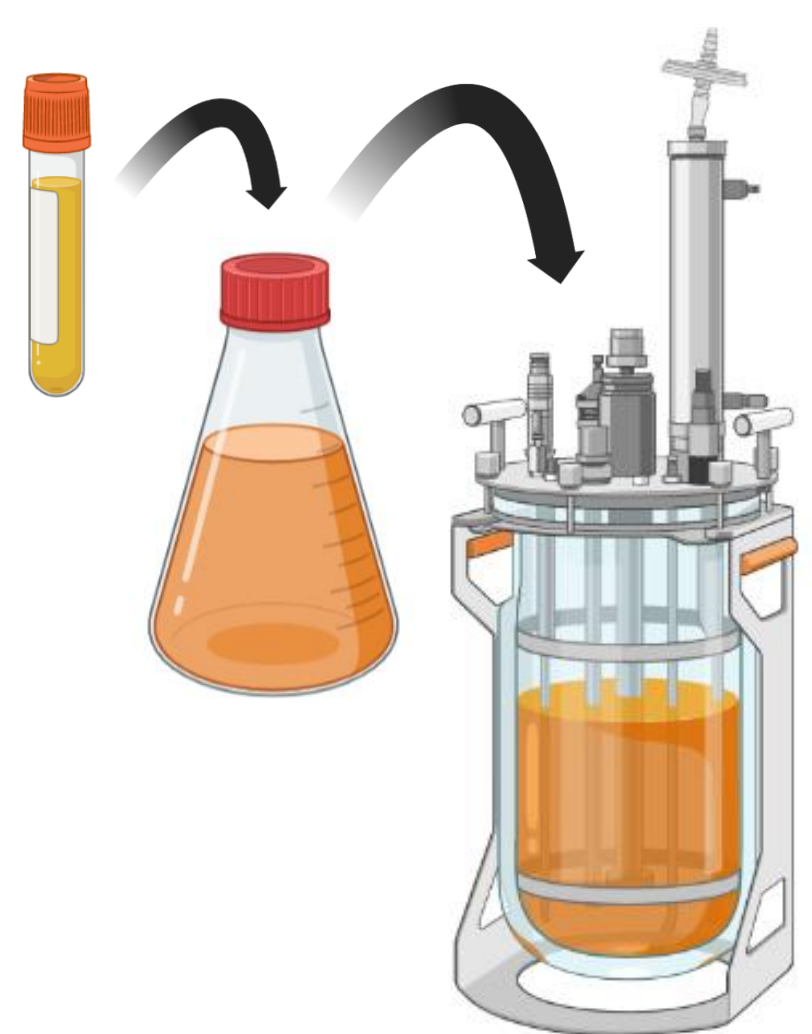
- Insulin → **Zinc sulphate** ↑↑
  - Albumin → **α-cyclodextrin**
  - TGF-β
  - bFGF
- Removed**



### GENERAL DIAGRAM

#### Upstream

##### Seed Train

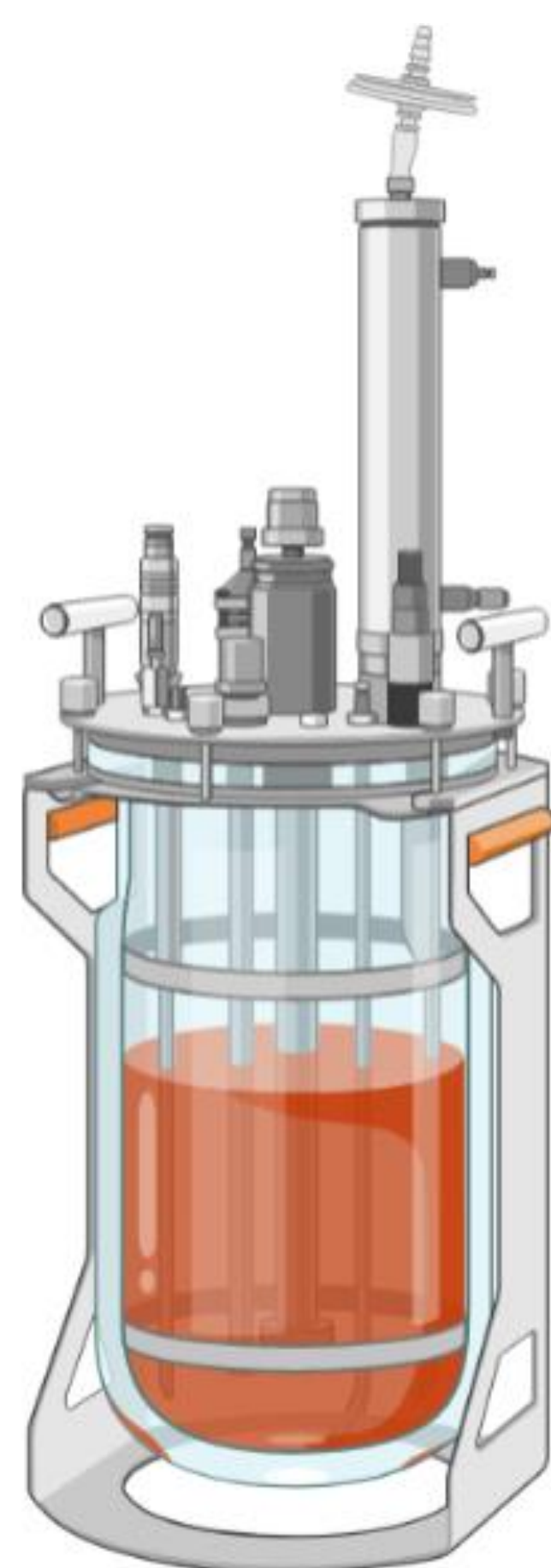


##### Serum-free culture media



#### Bioreaction

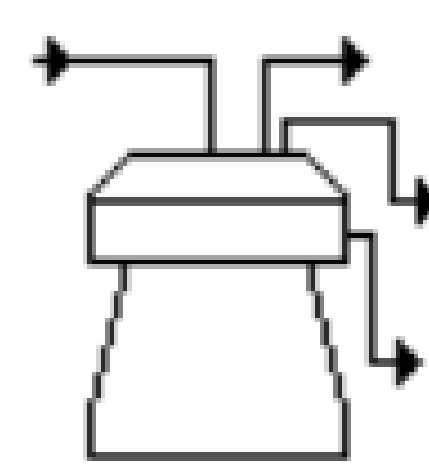
##### Proliferation and differentiation



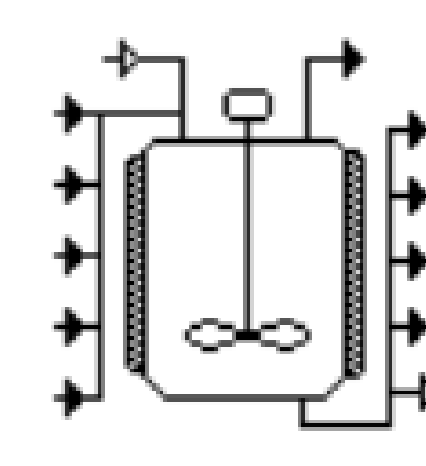
#### Downstream

##### Media and by-products removal

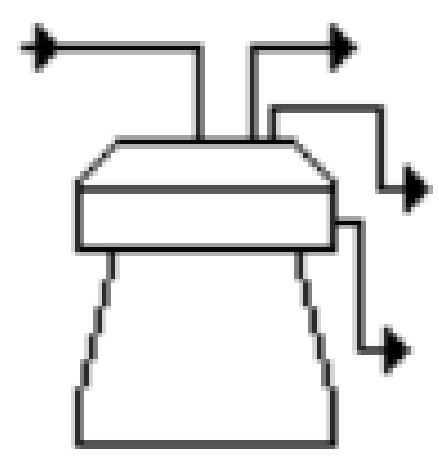
##### Centrifugation



##### Washing

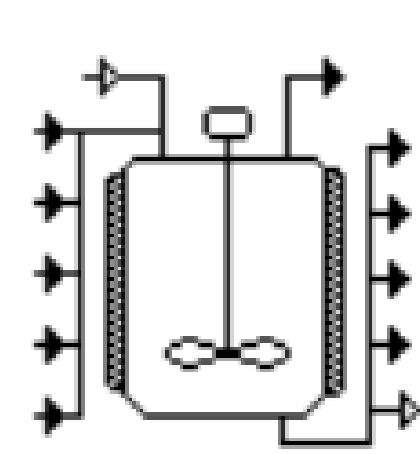


##### Centrifugation

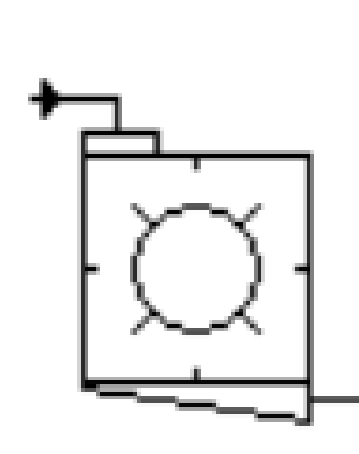


##### Meat processing

##### Mixing

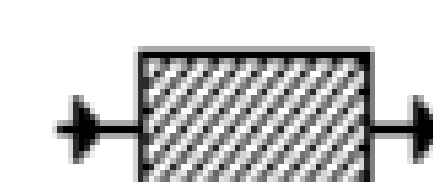


##### Grinding

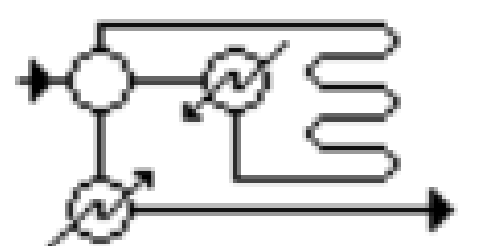


##### Final product elaboration

##### Packaging



##### HPP



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