Lab-Grown Meat:
How Stem Cells Will Change an Industry

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Abstract

The advancements of lab-grown meat offer an efficient, ethical, and environmentally friendly alternative to the current U.S. model of meat production. This poster demonstrates the applications of these new processes and how they are being implemented. Researchers have been focusing on creating reliable processes for lab-grown meat based on the acquiring and re-coding of stem cells. Stem cells are collected from a live cow sample and have the capability of becoming muscle cells. The cells are re-coded with the use of a nutrient serum and physical arrangement. Multiplication is induced through an assistive scaffold and mechanical process, which leads to substantial tissue samples.

With a rapidly increasing human population, meat demands are forcing harmful environmental strains to keep up with the expansion of livestock reserves and meat processing plants. Lab-grown meat already promises lower demands per volume of growth, including a 50% cut to energy demands. Beyond the environmental benefits, lab-grown products also may expand to a healthier product for consumption by limiting pathogen exposure and improving nutritional value.

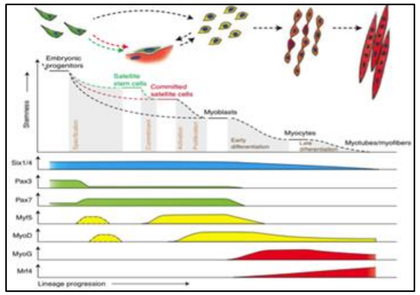
Memphis Meats was one of the first companies to put serious research and investment into lab-grown meats and provides a functioning example of these applications. Memphis Meats was able to successfully create the first lab-grown meatball in 2016, which had a cost decrease of 95% compared to itself only five years prior. The purpose of their research is to be able to replace the demand for livestock by growing all meat in labs. As the need for livestock animals is predicted to double by the year 2050, Memphis Meats has received attention from investors within the meat industry, showing expert validation for its valuable applications.

Ethics

- Due to growing concerns of mistreatments and unethical practices in the meat industry there are many factions who would like to see change.
- Not only are millions of livestock murdered every year, but they are mistreated beforehand on farms and in factories.
- Numerous workers in the industry work under harsh conditions with little pay.
  - Some are paid as little as two dollars per 2000 chickens they slaughter.
  - Many of these workers cannot challenge these conditions because they are working as illegal immigrants.
- Lab-grown meat eliminates the need to slaughter innocent animals since stem cells can be harmlessly extracted.
- With lab-grown meat, people will not have to worry about not eating meat due to certain moral or religious concerns.

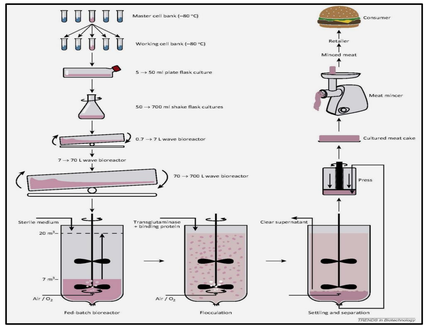
The Science to Growing Meat

1) The process starts with the extraction of stem cells from cows through a muscle biopsy.
   a) Scientists locate and stain the stem cells in order to separate them from the cells they do not need.
   b) Once separated and stained, the cells are extracted and stored in chemicals to keep them alive.
2) After extraction, the cells are transformed into myoblasts through different gene expression.
3) These myoblasts are cells that differentiate into muscle cells that eventually fuse together.
4) Myogenesis is the process of the muscle cells fusing together, and the result is numerous multinucleated myotubes, or strips of muscle.
5) This fusion and formation is due to the different gene expression which causes a change in the structure of these cells.



6) The cells work with proteins during this change of structure to develop contracting functions which promotes protein synthesis and muscle hypertrophy.
7) These myotubes need to be formed at a fast enough rate to pack together and become meat so scientist generally use two methods.
   a) The first method uses a gelatin ring that pushes muscle fusion and hypertrophy in the cells, creating myotubes at a much faster rate.
   b) The next method uses plastic microcarriers, a support matrix, to provide a larger surface for the cells to bind to, allowing for a larger production of myotubes at a time.

For these cells to survive after extraction from the cows, they sit in baths of chemicals that contain various salts, amino acids, vitamins, and sugars. These are all necessary for the survival of the cells as well as the temperature and carbon dioxide levels in the container to mimic the blood of the cows. Along with these chemicals, other serums such as fetal bovine serum and porcine gelatin are given to the cells to increase the rate of growth and formation of muscle.



Sustainability

Demands of Production Types

	Livestock	Lab-Grown
Land	Each cattle require 232 sq. meters to habituate	A single laboratory could host as many samples as there is incubators
*Water**	Requires 1,500 gallons of drinkable water	Requires around 90% less
*Feed/Energy**	26.8 pounds of feed and 4,144 BTUs of energy	Requires 45% less energy and no feed
Energy Efficiency	26 calories required: 1 calorie of meat	3 calories required: 1 calorie of meat

**Measured requirements per pound*

Pollution

- Upwards of 20% of the world's greenhouse gases are omitted by livestock.
- Greenhouse gases omitted by livestock include methane, which is 30 times more harmful than carbon monoxide and nitrous oxide, which is over 250 times more dangerous than nitrous oxide.
- The deforestation that is required to expand livestock pastures also inhibits the ability of the environment to combat these gases
- Lab-grown meats give off almost no greenhouse gases, and are therefore much safer for the environment.

Timeline of Innovation

1995: U.S. Food and Drug Administration approves commercial use of in-vitro meats.

2006: Concept and proof of idea to use stem-cells to grown meat showcased by Jason Matheny.

2013: First lab-grown beef patty produced at the Dutch University of Maastricht by Prof. Mark Post for $130,000.

2015: American in-vitro meat start-up, Memphis Meats founded by Dr. Uma Valeti and Nicholas Genovese

2016: Memphis Meats reveals its first lab-grown meatball which cost $18,000 to produce. The tasting attracted news source headlines.

2017-18: Memphis Meats gains $17 million of financial backing from Bill Gates and industry leader Tyson Meats