

## FUTURE FOOD—CAN CULTIVATED MEAT SAVE OUR PLANET?

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### YOUNG REVIEWERS:



**ANTONIO**

AGE: 10

Think about what humans will eat in the future. Could you imagine eating meat produced without the extensive farming of animals? This scenario is not as unlikely as you might think. To protect our planet, we must reduce the irreversible damage we are doing to the environment. Eating less meat is a major part of this, because the way we produce most meat today has a tremendous impact on the environment. Plant-based meat alternatives are already available in stores, but it is hard to imitate the taste and texture of meat if no animals are involved. Therefore, scientists have been working on an alternative, called cultivated meat, that is made from real animal tissue but does not require the death of the animal. Cultivated meat shows great promise to become an environmentally and animal-friendly alternative to conventional meat. However, there are still limitations to cultivated meat products that prevent them from being sold in stores.

## CULTIVATED MEAT

Cultivated meat is identical to the meat that people eat today and is produced by multiplying animal cells without slaughtering animals.

### Figure 1

The production process of a cultivated beef burger. **(A)** First, muscle stem cells are removed from a cow through a biopsy. **(B)** The isolated muscle stem cells are expanded on a small scale, in a flask for example. **(C)** The muscle stem cells are then transferred into a bioreactor for proliferation (rapid multiplication) and differentiation (development into muscle fibers). **(D)** Finally, the muscle fibers are processed into a meat product like a burger patty.

## STEM CELLS

Cells from which all specialized cell types of the body are generated. They can be thought of as the raw materials of our bodies.

## BIOPSY

A small sample of tissue removed from a living organism.

## PROLIFERATION

A rapid growth or multiplication of cells.

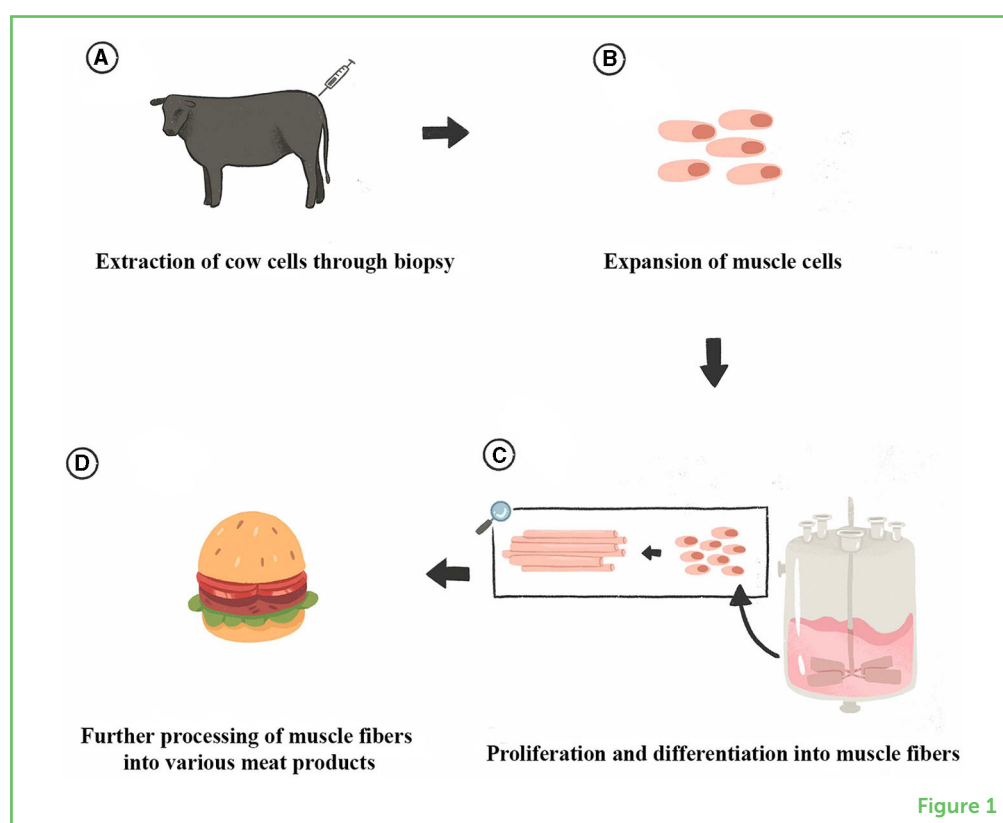
## BIOREACTOR

A vessel in which cells or microorganisms can

## THE FUTURE OF OUR FOOD

Imagine the year 2050. You and your friends are sitting at your favorite fast-food restaurant ordering the same burger that you have eaten since you were young. Although it has the same texture and taste, there is something different about it this time. While the burger patty is made from meat, no animals had to die to produce it.

What you have just eaten would be called **cultivated meat**. Cultivated meat is predicted to become a common alternative to conventional ("normal") meat in a few years. Although scientists are working to make sure that cultivated meat has the same make up, texture and taste as conventional meat, the way it is produced is much different [1] (Figure 1).



Simply put, cultivated meat is produced from animal cells. There are several ways to produce cultivated meat including the cultivated beef burger patty in our example. In the most common method, the first step is to take muscle **stem cells** from the muscle tissue of a cow (Figure 1A). This process is called **biopsy**, and it does not require the death of the animal [1]. In the next step, the muscle stem cells are grown in the lab (Figure 1B). Here the cells first multiply in a small culture system, for example a flask. This growth process is called **proliferation**. They are then transferred to a larger tank called a **bioreactor** (Figure 1C). The bioreactor contains a medium, which provides the ideal conditions and nutrients for the cells to grow rapidly.

be grown in a cell culture medium under controlled and regulated conditions, such as optimal temperature and pH.

## DIFFERENTIATION

A process in which the structure of the cells changes, thereby changing the functions of the cells.

## CO<sub>2</sub>-EQUIVALENT

A measuring unit for the global warming potential of all greenhouse gases (e.g., CO<sub>2</sub>, methane).

### Figure 2

In the future, restaurant menus might include the same burger made with either conventional beef (left) or cultivated beef (right). The environmental impact is illustrated under each burger. One car equals the CO<sub>2</sub>-equivalent of a 10 km car ride in a medium-sized, diesel-powered car. The environmental impact was calculated based on 120 g of beef in each burger (standard burger patty size).

After the cells grow enough, the conditions within the bioreactor are changed, which makes the muscle stem cells fuse together into clusters, which then change into muscle fibers and larger tissues. This change process is called **differentiation**. Finally, this cultivated meat can be processed into various products (Figure 1D), such as a burger patty [1].

## THE MEAT INDUSTRY: A MAJOR DRIVER OF CLIMATE CHANGE

In addition to potential moral concerns (e.g., animal welfare, the ethics of harming other living beings) and health issues (e.g., diseases transmitted through meat products or use of antibiotics to treat farmed animals), the conventional meat industry also has a negative impact on the environment. The production of a conventional beef burger patty requires a lot of land and water. Conventional meat production also contributes a large part to the accumulation of greenhouse gases, which are responsible for global warming. The production of animal feed, the digestive processes of livestock, and the long transportation routes needed to get meat to consumers all lead to greenhouse gas emissions. The production of one beef burger patty can cause the emission of 25 kg **CO<sub>2</sub>-equivalent** [2], which is more CO<sub>2</sub> than a 100 km car ride produces [3] (Figure 2).

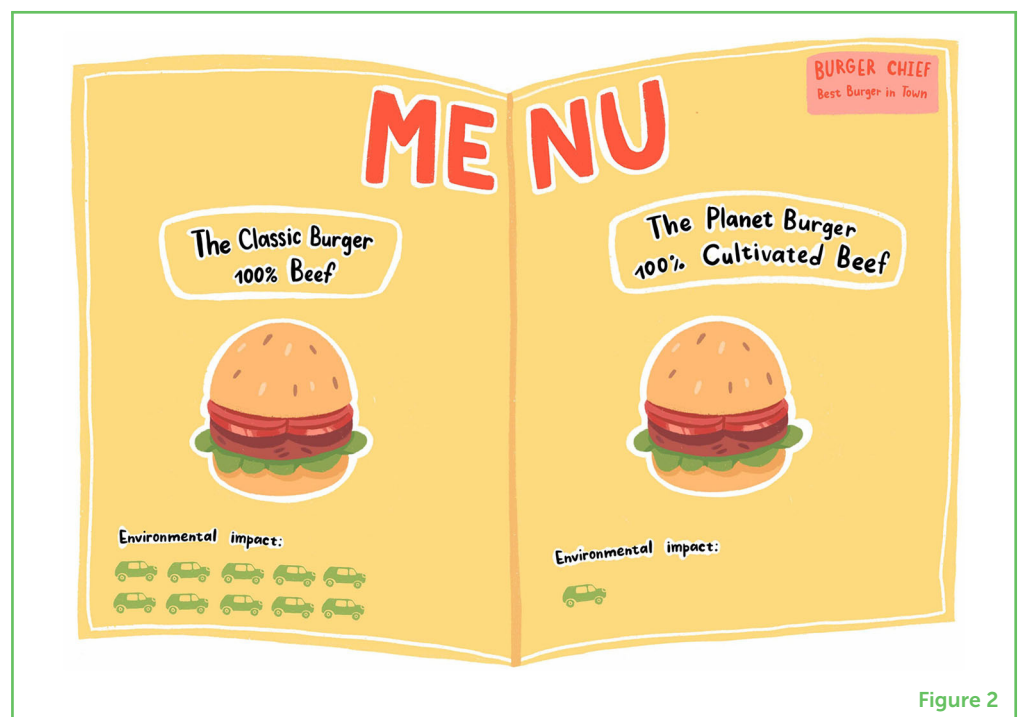


Figure 2

An average adult from the United States consumes about 25 kg of beef per year, which is enough to produce approximately 208 burger patties. Given that the United States has more than 300 million inhabitants and other meat such as pork and chicken is not included in

these numbers, the production of such a large amount of meat every year is extremely hard on the environment [4]. Scientists estimate that there will be 10 billion people on our planet by 2050, which is 2 billion more than today. As a result, the demand for meat is estimated to triple in the next 30 years. However, our planet's resources will not be sufficient to supply the world's population with the necessary amount of meat, which increases the pressure to find sustainable alternatives to conventional meat [1, 5].

## CULTIVATED MEAT COULD HELP THE CLIMATE

Producing cultivated beef instead of conventional beef has many benefits. For example, there is no need to kill animals to produce cultivated meat. Perhaps more importantly, cultivated meat does not require huge numbers of animals to be farmed in mass stocks. Because the production of cultivated meat does not require animals to be slaughtered, fewer animals would need to be housed and fed. As a result, cultivated meat production would require considerably less land and water than conventional meat production does. In fact, land use for meat production could potentially be lowered by 99% and water use could be reduced by up to 96% if we were to completely switch to cultivated meat production [5]. Additionally, there would be a rapid decrease in greenhouse gas emissions. Switching to cultivated meat could potentially reduce emissions from raising livestock by as much as 90% [6]. Cultivated meat could therefore make up a significant portion of the meat required to feed the world's increasing population, without harming the environment nearly as much as conventional meat production does [1].

## WHY IS CULTIVATED MEAT NOT BEING SOLD YET?

The idea of cultivated meat has been around for a long time—it was first proposed in the 1930s. Nevertheless, the first cultivated meat product, a cultivated beef burger patty, was not produced until 2013. Today, approximately 10 years later, there are still no cultivated products commercially available in the United States or the European Union [5]. This is because there are still many issues surrounding the production and sale of cultivated meat (Figure 3).

A major problem is technical. One of the ingredients in the growth medium used for the proliferation of the muscle stem cells is fetal bovine **serum**, which is made from the blood of an unborn cow. Scientists still do not know if the serum is completely suitable for human consumption and, on top of that, it is expensive. As a result, scientists around the world are currently trying to develop cell growth media based on bacteria, yeasts, fungi, or microalgae, in an attempt to eliminate the need for fetal bovine serum to grow cultivated meat [1].

### SERUM

A component of blood that contains, among other things, proteins, and growth factors. In the production of cultivated meat, mainly fetal calf serum is used.

### Figure 3

Current challenges in cultivated beef production. The girl with the tray in her hands wants to try the new cultivated beef burger, but she cannot get to the booth unless the hurdles are overcome. The hurdles represent the challenges for cultivated meat to be adopted on a larger scale in society.

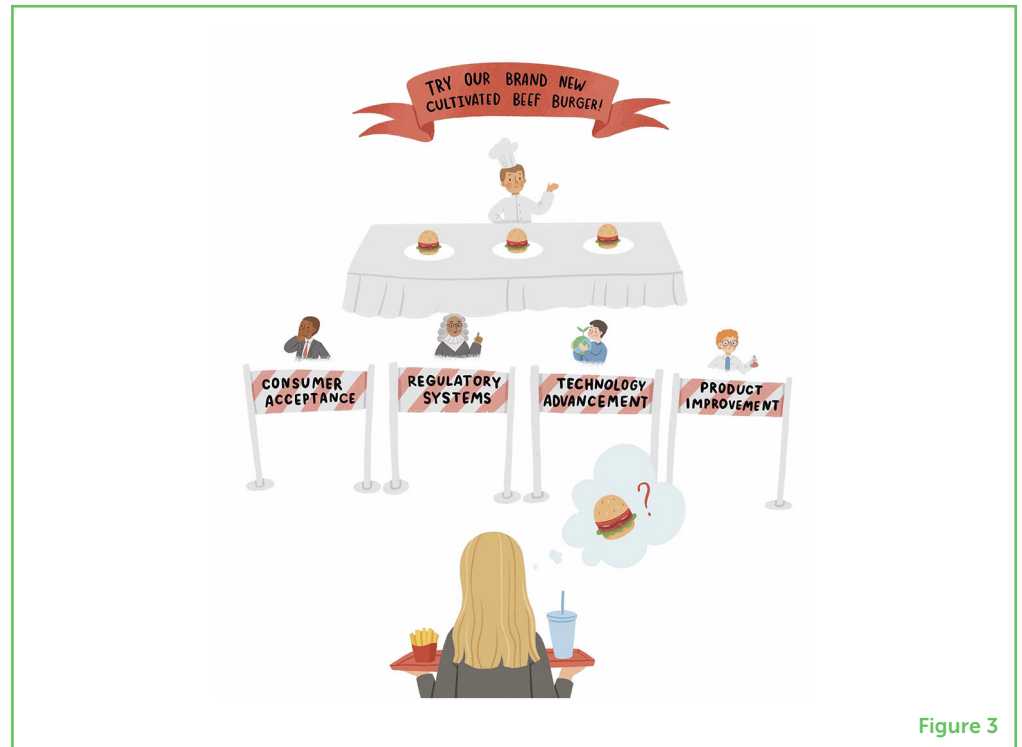


Figure 3

There are a few other reasons why cultivated meat still cannot compete with conventional meat products. One is that it is very expensive to produce on a large scale. Also, until the technology advances, producing cultivated meat still requires a lot of energy. Plus, it is not yet possible to reproduce the diversity and texture of all meat products [2, 5]. Additionally, there are strict regulatory systems in many countries, such as those in the United States or European Union, that need to approve food products before they can be sold on the market. Many governments require novel foods to be safe, pure, and wholesome, so they must be tested in a lengthy process [7].

Most importantly, consumers must ultimately accept the new meat alternative. This might pose another problem, as many people might think that cultivated meat is unnatural in comparison to conventional meat products [5].

Despite all of the challenges that face cultivated meat production, scientists are constantly working to improve the production process. They have already identified a growth medium that does not require fetal bovine serum, for example [1]. The taste and texture of cultivated meat products are also constantly being optimized. In a few years, it might be difficult to tell the difference between a conventional beef burger patty and the cultivated alternative [1].

Furthermore, studies have shown that the impact on our environment would be rapidly reduced if the production of cultivated meat switched to sustainable energy sources, like solar or wind. This would make

cultivated meat far more eco-friendly than all conventional meat products [2].

In terms of consumers' acceptance, there is hope that people will be more tolerant of new food products in the coming years. Although many people will not yet buy cultivated meat as an alternative to conventional meat, an increasing number of people are willing to try it. Acceptance of any new product is highly dependent on the way information about that product is communicated, which raises the hope that increased education about cultivated meat could lead more people to accept it [1].

## A FORECAST FOR THE FUTURE

Is all this just a science-fiction dream, or is there an actual chance of eating a cultivated beef burger at your local fast-food restaurant in the future? If scientists are successful in solving the problems that still prevent cultivated meat from being sold on the market, it could actually overtake conventional meat one day. A current market analysis predicts that cultivated meat will make up more than one-third of the total amount of meat sold by 2050. By then, conventional meat may account for only 40% of the global meat market. The remaining 25% will be made of plant-based meat alternatives [1].

Cultivated meat has the potential to rapidly reduce the harmful environmental effects of the conventional meat industry. It would therefore be a huge step toward fighting climate change, which is one of society's biggest concerns—today and for future generations. Although there are still obstacles to the production of cultivated meat, scientists are constantly working to make it a realistic alternative to conventional meat [1].

Now that you understand what cultivated meat is all about, what do you think? Would you give it a try?

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Antonio loves learning about plants and is an avid birder. He enjoys reading about topics in botany, chemistry, and zoology, but also makes time for playing soccer and watching Naruto.

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Paula Meyer is a master's student at Osnabrück University. She is studying both biology and English with the intention to become a teacher. As part of her bachelor's thesis, she focused her research on cultivated meat and its environmental consequences. Paula is very interested in environmental protection as well as



plant-based nutrition and thinks that cultivated meat shows great potential to reduce the environmental impact of the conventional meat industry. To maintain a healthy and eco-friendly lifestyle, Paula enjoys trying out new plant-based recipes as well as exercising.



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Lena Szczepanski is a teacher of physics and biology and a Ph.D. student in biology didactics at Osnabrück University. Her research focuses on adolescents' perceptions and acceptance of novel foods such as cultivated meat or animal-free dairy. She has a keen interest in Education for Sustainable Development and strives to connect her research with her teaching. She believes that novel foods like cultivated meat can contribute to the necessary change in dietary habits to address current environmental problems. To clear her mind, Lena enjoys baking and practicing wheel gymnastics in her free time. \*[lena.szczepanski@uni-osnabrueck.de](mailto:lena.szczepanski@uni-osnabrueck.de)



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Milan Büscher is an environmental psychologist currently working on his Ph.D. in the biology didactics working group at Osnabrück University. His research focuses on social science biodiversity conservation and understanding the factors that influence impactful conservation behavior. With his background in psychology, he brings a unique perspective to conservation efforts and is committed to making a difference in the field. Milan enjoys spending his free time outdoors and experimenting with vegan cooking. He believes that cultivated meat could be a key part of making diets more sustainable and hopes that it can help protect our planet's biodiversity.



#### **JULIA SCHÄCHTELE**

Julia Schächtele is dedicated to science communication in the field of food, nutrition, and agriculture. She works at both Osnabrück University and Osnabrück University of Applied Sciences. As a trained editor with a master's degree in agricultural and food economics, she uses her expertise to make scientific findings more understandable, accessible, and entertaining. Her aim: to accelerate change in the agri-food sector to meet environmental challenges. When not at her desk, Julia experiments with self-sufficiency in her community garden.



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Florian Fiebelkorn is a biology and chemistry teacher and has been working as a researcher at the University of Osnabrück in the fields of sustainable nutrition and biodiversity conservation for several years now. His main goal is to convince people to implement more sustainable behaviors in their daily lives. Besides his job as a researcher, he loves to cook vegan food and go on long bike rides in beautiful landscapes. Furthermore, he tries to get his jumbled mind under control through yoga and meditation.