MEAT THE FUTURE

EDUCATIONAL GUIDE

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OVERVIEW

Welcome!

Thank you for picking up the Educational Guide and bringing *Meat the Future* to your school or community.

We hope the documentary and resource can inform, inspire, and engender new conversations in your courses, with your students, and in your communities.

FILM SUMMARY

Imagine a world where real meat is produced sustainably without the need to breed, raise and slaughter animals.

PRESENTING A GAME-CHANGING SOLUTION, *MEAT THE FUTURE* IS NARRATED BY DR. JANE GOODALL, AND FEATURES MUSIC BY MOBY.

This is no longer science fiction, it's now within reach. At the forefront of this urgent frontier is Mayo Clinic-trained cardiologist **Dr. Uma Valeti**, the co-founder and CEO of Upside Foods (previously Memphis Meats), the leading start-up of the "cultivated" meat revolution. From the world's first meatball which cost $18,000 per pound to the first chicken fillet and duck a l'orange for half the cost, the film follows Valeti and his team over five years as the cost of production plummets, and consumers' eye the imminent birth of this timely industry.

USING *MEAT THE FUTURE*

If you are faculty at a college or university, the documentary and guide provide a springboard for coursework and research topics to explore including:

- Science and food technology working together for climate solutions.
- Animal ethics and humane food production.
- The correlations between conventional animal agriculture and land and water use, greenhouse gas emissions, deforestation, and biodiversity loss.
- The policies and strategies necessary to prevent future health pandemics.

If you are a high school educator and want to use the documentary for units in Biology, Chemistry, Philosophy/Ethics, Business and Economics, please do. The suggested background, digging deeper topics, and analyzing point of view exercise can be easily adapted and used to enrich an existing lesson or frame new units of study for students in 9-12th grades.

For other school-based activities, corporate or community organizations focusing on climate and the environment, food sustainability, science and technology, the treatment of animals, or business and futurism, *Meat the Future* together with this resource is an invaluable tool to initiate new dialogue about potential game-changing solutions.

DIRECTOR'S STATEMENT

In 2016, I was looking to follow an active character-driven story about a solution to the various global emergencies facing our future. I learned about the world's first meatball made from cells, without the need to slaughter animals, and the more I researched the more I realized that this novel innovation could be a silver bullet to the climate crisis, animal suffering, and global health pandemics. After meeting with Dr. Uma Valeti, a Mayo Clinic-trained cardiologist from Vijayawada, India, I felt certain there was a film. In 2015, Uma took a risky passion-driven career turn and founded Memphis Meats, the world's first startup focused on the commercial viability of meat grown from animal cells. His story was compelling and I asked to feature him and his small team in a documentary about the birth of this fascinating industry. Uma agreed, and over the next five years my lens was situated at the forefront of a historic and hopeful movement of change. The story of Memphis Meats (rebranded as Upside Foods) continues to accelerate. Uma's risk paid off, and so did mine.

Chronicling this story over several years meant witnessing historic milestones and riding the wave of many twists and turns. The industry continues to evolve and change with new technology, scientific breakthroughs, private and public investments, hopes and disappointments, hyperbole and skepticism, and new language. What the future holds for cultivated meat is unclear, but I believe its revolutionary journey into the world, as captured in *Meat the Future,* will stand the test of time.

— Liz Marshall

“WHAT THE FUTURE HOLDS FOR CULTIVATED MEAT IS UNCLEAR, BUT I BELIEVE ITS REVOLUTIONARY JOURNEY INTO THE WORLD, AS CAPTURED IN *MEAT THE FUTURE*, WILL STAND THE TEST OF TIME.”

– LIZ MARSHALL

BACKGROUND

"The way we make meat is at a breaking point. As our planet faces unprecedented challenges, we need unprecedented solutions. Imagine a world where meat comes from animal cells and not animal slaughter, where your favorite food is a force for good. Because fixing our food system is not just about fixing our food, it's about our shared humanity."

— UPSIDE FOODS

THE BIRTH OF A NEW INDUSTRY

There is a new food science, referred to as "cellular agriculture" that harvests' cells from animal tissue (eg. extracted from a painless biopsy) to enable the growth of meat, fish, seafood, dairy and eggs (and even leather.) The process begins by acquiring stem cells from an animal. These cells are then grown in bioreactors (also known as cultivators) at high densities and volumes. Similar to what happens inside an animal's body, the cells are fed a nutrient rich medium that triggers cells to become skeletal muscle, fat, and connective tissues that make up meat. Within 2-8 weeks, these are harvested, prepared, and packaged into final products.[1]

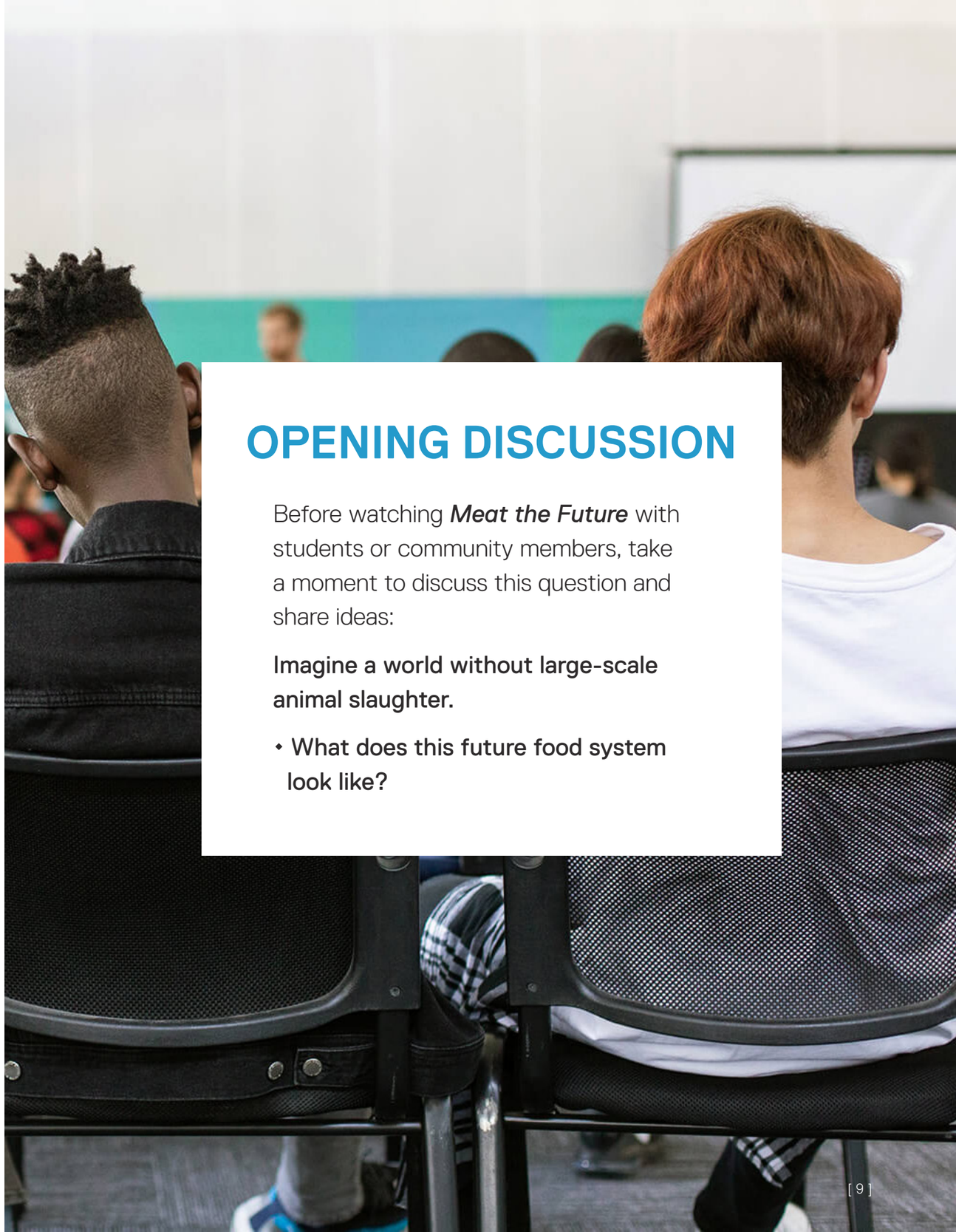
NEW INFORMATION MUST BE PRESENTED BOTH IN AN ENGAGING FORMAT AND IN A FRAMEWORK THAT ENABLES PEOPLE TO INCORPORATE NEW INFORMATION INTO THEIR EXISTING BELIEF AND VALUE SYSTEMS.[3]

Refer to **Appendix III** for additional information.

THE EVOLVING NOMENCLATURE

In the report, "Meat Cultivation: Embracing the Science of Nature"[2] researchers from The Good Food Institute found that when new science topics are discussed in the public sphere they are either categorized as (1) controversial (a debated topic like genetic engineering) or emerging (not yet well known.) Once they are "controversial" it is often very difficult to reverse opinions on their line of thinking. With the emergence of cellular agriculture, it is important to form relatable and "positive awareness" of the process and the product so when supply is available, consumers are informed.

For these reasons, the current (2022) preferred industry-wide name is **cultivated meat**, which includes the innovation of cell-based beef, pork, poultry, fish and seafood. You may also come across a slew of other terms such as "clean meat" "cultured meat" "cell-based meat" "cellular meat" "lab-grown meat" "in-vitro meat", but the industry is shifting the conversation to adopt the term to "cultivated meat."



OPENING DISCUSSION

Before watching ***Meat the Future*** with students or community members, take a moment to discuss this question and share ideas:

Imagine a world without large-scale animal slaughter.

- **What does this future food system look like?**

POST

SCREENING

FACILITATING A DISCUSSION

Invite initial thoughts, reactions, and questions that arose during the documentary.

If helpful, here are additional questions to stimulate conversation:

- **Would you try cultivated meat? Why or why not?**
- **What might make people curious and interested?**
- **What might make people hesitant or resistant?**

Share: animal agriculture is responsible for approximately 14.5 percent of global greenhouse gas emissions, according to the United Nations' Food and Agriculture Organization. This puts the sector on par with transport which is responsible for 14 percent of emissions.[4]

- **Knowing this, what are your reactions to the emergence of the cultivated meat industry?**

"Cultivated meat would allow producers to meet the growing demand for animal protein while eliminating the pressure to clear wild land for feed crops worldwide."[5]

- **What are other potential benefits with cultivated meat?**
- **How important is the treatment of animals in the food choices you make?**

IMAGINE A WORLD WHERE REAL MEAT IS PRODUCED SUSTAINABLY WITHOUT THE NEED TO BREED, RAISE AND SLAUGHTER ANIMALS. THIS IS NO LONGER SCIENCE FICTION, IT'S NOW WITHIN REACH.

DEBUNKING MYTHS

Discussing commonly held misconceptions is a thoughtful approach to unraveling our assumptions and opening up new avenues for learning.

- Organize into small groups and have participants discuss responses to each myth.
- Post myths around the room. Have participants circulate and discuss myths in small groups.
- In pairs, discuss the the differing points of view associated with this myth.

DEBUNKING
MYTHS

01

Cultivated meat is not real meat

As you have learned from the film, cultivated meat is real meat, grown differently from conventional meat. The process of producing cultivated meat is similar to brewing beer or culturing yogurt. Instead of growing yeast or microbes, animal cells are grown in a sterile environment, without the need to slaughter animals.

02

Cultivated meat is not an answer to the climate emergency

Conventional animal agriculture demands an enormous footprint, and while there will be an energy footprint to produce cultivated meat at scale, production will rely on clean renewable energy sources, water-capture and recycling. Cultivated meat production is not expected to produce GHG emissions, or to contribute to acidification of land and water, soil degradation, or to deforestation with resulting biodiversity loss and land encroachment.

03

Cultivated meat will put farmers and ranchers out of business

When cultivated meat reaches scale, there will be a myriad of new businesses around it generating employment opportunities, innovation, safety, and sustainability practices, which together will bring benefits to workers and the economy. A new ecosystem of demand and supply is underway and it will intersect with current food systems, to evolve and grow the future of food.

04

It will always be expensive and inaccessible

Scaling the production of cultivated meat and making it affordable and accessible is a top priority of the industry, and it will take time. In just the past few years, the cost of production has dropped significantly, as shown in the film. As more investors are involved, as governments fund research, as cultivated meat is regulated and comes to market globally, it will become common-place.

05

What are other myths?

As a class or group brainstorm one or more myths that come to mind and discuss ways to debunk it.

DIGGING DEEPER

Digging Deeper invites educators and students to explore some of the most pressing topics raised in *Meat the Future* — the climate crisis, food security and sustainability, public health, animal protection, the role of science and innovation in food production, and food oversight and regulation.

Each topic includes discussion questions, additional context, and suggested resources for research to deepen understanding and strengthen critical media analysis.

FOOD PRODUCTION AND THE CLIMATE CRISIS

Discuss:

In what ways will producing cultivated meat at scale address the climate emergency?

> WHEN PRODUCED AT SCALE, CULTIVATED MEAT WILL REDUCE THE LAND AND WATER FOOTPRINT REQUIRED FOR CONVENTIONAL ANIMAL AGRICULTURE.

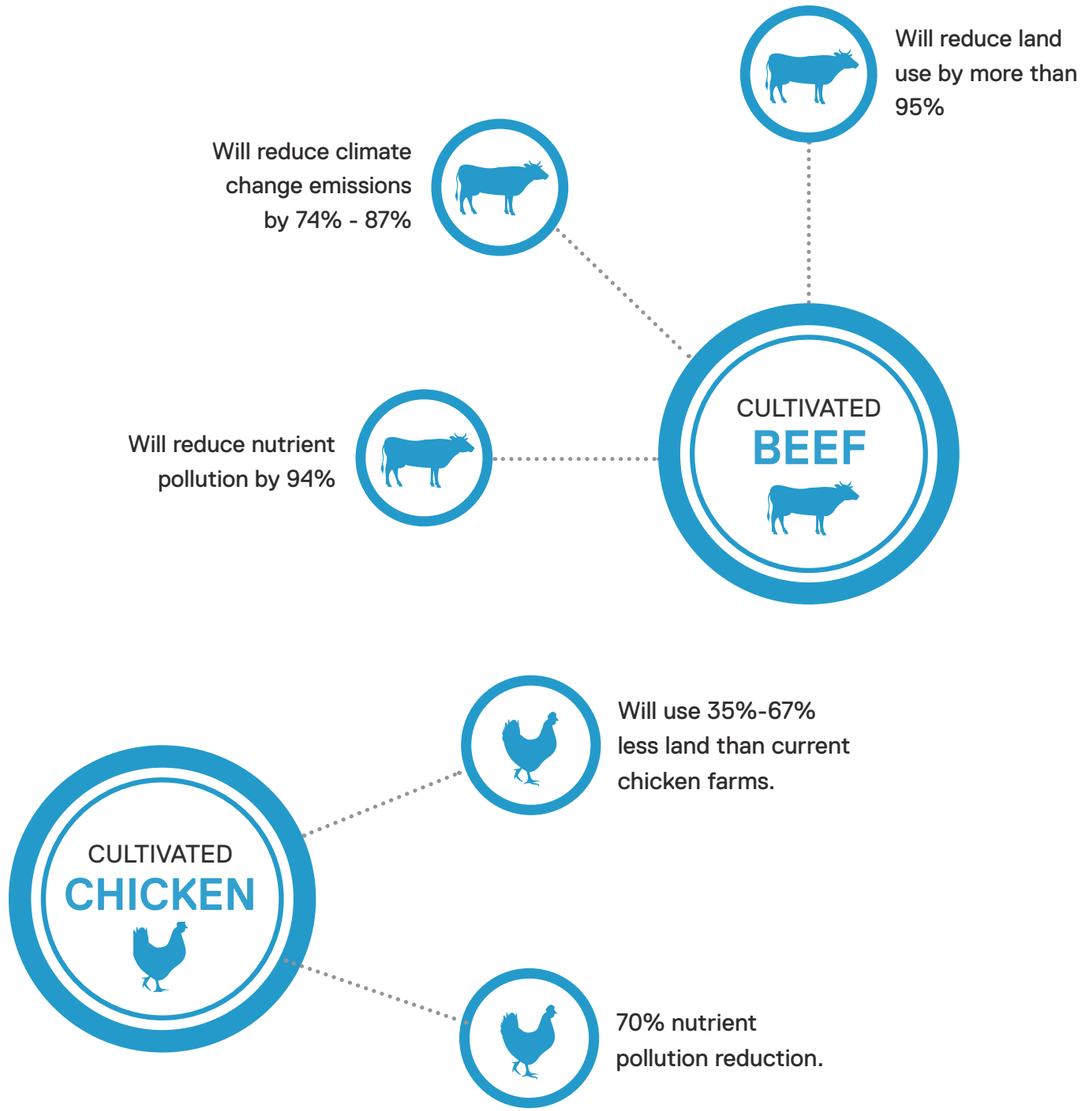
In turn, land could be dedicated to efforts of carbon sequestration (reforestation) as well as reducing CO_2 and methane being emitted as a result of animal waste. Animal agriculture and related land use generate one-quarter of annual GHG with the three most consumed meat, cattle, sheep, and goats using two-thirds of global agricultural land and contributing roughly half of agriculture production-related emissions.[6] Livestock raised for meat (mainly cattle) emit methane (CH_4) through their digestive processes and manure. The ever-increasing need to clear land for grazing and to grow feed drives deforestation, an increase in the release of carbon dioxide (CO_2) emissions and a decrease in biodiversity.[7]

Because cultivated meat has not yet been produced commercially at a large scale, estimates on its impacts are based on research projections. The studies that have been conducted point to promising results.[8]

Suggested Reading

"Here's How Much Food Contributes to Climate Change," *Scientific American*, September 13, 2021.[9]

A GAME CHANGER



(**Source**: https://gfi.org/wp-content/uploads/2021/01/sustainability_cultivated_meat.pdf)

FOOD AND OUR HEALTH

Discuss:

What are the health benefits of reducing or eliminating meat consumption?

Meat production and public health are interconnected.

Many infectious diseases in humans originate from animals--about 75% of emerging infectious diseases are zoonotic. For example, Covid-19 is a zoonotic disease. Zoonosis is transmitted from animals to humans, from close contact with live animals, their infected tissues and fluids, from wildlife and the slaughter and hunting of animals.

Cultivated meat could help prevent future health pandemics and decrease food borne illness and bacterial pathogens (eg. Salmonella, E-coli, and Listeria.) It could also minimize antibiotic resistance that is a result of the overuse of antibiotics in animals raised for slaughter to prevent viruses from spreading.

Suggested Readings

"Nutrition and Healthy Eating," Mayo Clinic, August 20, 2020.[10]

"An Inconvenient Lesson From the Pandemic: We Have to Stop Eating Meat," *The New Republic*, July 31, 2020.[11]

FOOD SECURITY AND SUSTAINABILITY

Discuss:

Could cultivated meat address food justice concerns? (eg. local, affordable, healthy, and culturally appropriate foods.)

By 2050 there will be nearly 10 billion people on our planet.

Over the past fifty-plus years global meat production (in tonnage) has increased over 4.5-fold, nearly twice the rate of population growth.[12] Incomes will continue to increase in the developing world with meat demand expected to double.

WITH YIELDS FLATTENING, THE DEMAND FOR ANIMAL PROTEIN GROWING, THE POPULATION INCREASING AND INCOMES IMPROVING, AND AN INCREASING RATE OF LAND DEGRADATION, THE HEADWINDS AGAINST THE FOOD SYSTEM REACHING ITS CRITICAL GOAL ARE ALMOST INSURMOUNTABLE.[13]

Our current mode of food production cannot sustainably feed this population. New methods of growing food is in fact, one of the 17 UN Sustainability Goals speaks to this need—Zero Hunger.[14]

Suggested Reading

"The Future of Food: Feeding the World," *National Geographic*.[15]

ANIMAL PROTECTION

Discuss:

How else can the world's food systems change to lessen animal suffering?

Cultivating meat directly from animal cells eliminates the need to breed, raise, and slaughter billions of animals.

It is known that more than 70 billion land animals annually and globally are slaughtered within the meat industry.

Suggested Resource

Explore the Harvard Animal Law and Policy Program and choose any of their most recent articles posted in their News Section.[16]

SCIENCE AND INNOVATION

Discuss:

How can innovation and science work together to meet the growing demand for protein?

In November 2021 Upside Foods opened its Engineering, Production, and Innovation Center (EPIC). They broke ground in the midst of the global pandemic and opened the world's most advanced production facility for cultivated meat.

At capacity, the Upside Meat facility will be able to produce 400,000 pounds of meat a year.

Suggested Readings

Lab-Grown Poultry, *Time* Magazine The Best Inventions of 2021[17]

"UPSIDE Foods opens its first cultivated meat production facility," Virgin.com[18]

HOW CAN INNOVATION AND SCIENCE WORK TOGETHER TO MEET THE GROWING DEMAND FOR PROTEIN?

OVERSIGHT AND REGULATION

Discuss:

Why is the regulation of cultivated meat essential?

The oversight and regulation of cultivated meat will evolve as rapidly as the product itself. Countries with high consumption of meat and seafood are currently considering or developing frameworks to regulate and introduce cultivated meat and seafood within regulated food markets.

Here's a recent snapshot:

Asia Pacific

Singapore: The Singapore Food Agency (SFA) published in 2020 their "Requirements for the Safety Assessment of Novel Foods."[19]

Australia-New Zealand: The Food Standards Australia New Zealand (FSANZ) is the joint regulatory framework and food regulatory agency. The FSANZ states that cultivate meat and seafood would fall under the "novel food" regulation. To date the FSANZ has not yet been approached by a food business seeking regulatory approval.[20]

Canada: Cultivated in Canada is considered novel foods and requires a detailed application for premarket approval. See the recently published "Cellular Agriculture & The Canadian Regulatory Framework"[21] from Cellular Agriculture Canada.

European Union: In the EU cultivated meat is regulated by The Novel Foods Regulation[22] which governs pre-market authorization for foods produced from animal cell or tissue culture.

United Kingdom: As of May 2021, and UKs exit from the European Union, any cultivated meat company must apply for authorization from the UK Food Standards Agency (FSA). The primary difference in regulation between the UK and the EU comes down to final approval. In the UK it will reside with government ministers as opposed to the European Commission and representation from all twenty seven EU member states.

United States: In 2019 the U.S. Department of Agriculture (USDA), the U.S. Food and Drug Administration (FDA), and the USDA Food Safety and Inspection Service (USDA-FSIS) established a formal agreement on the regulatory tools used to help ensure that foods containing cultured animal cells entering the U.S. market are safe and properly labelled.[23]

Suggested Reading

"Cell-based meat faces a major challenge in regulatory approval," *Food Business News*, July 13, 2021.

"Trends and ideas in technology, regulation and public acceptance of cultured meat," *Future Foods*, Volume 3, June 2021.[24]

ANALYZING

POINTS OF VIEW

Meat the Future offers an engaging opportunity to take a front-row seat to the growth of a visionary new industry that affects everyone. This section offers the opportunity to discuss, analyze, and weigh different points of view to come to a deeper understanding.

1. CHOOSE TWO OR MORE ARTICLES AND COMPLETE A CLOSE READING

Make sure you are annotating important information as you complete each article.

"Lab-grown food will soon destroy farming - and save the planet"[25] *The Guardian*, January 8, 2020.

"Lab-grown meat is supposed to be inevitable. The science tells a different story"[26] *The Counter*, September 22, 2021.

"What questions should we be asking about cell-based meats?"[27] *Forbes*, May 26, 2021.

"Let's Launch a Moonshot for Meatless Meat" Opinion, *New York Times,* April 24, 2021.[28]

2. DISCUSS THE CLAIMS AS A CLASS OR IN A SMALL GROUP

- Who wrote the article? What organization or news affiliate published the article?
- What, if anything, do these details potentially reveal about the point of view of the author? (If you are not familiar with the news source, do your research. Who funds their operations? Is it an established accredited news outlet, non profit organization, or an advocacy organization? Why does this matter? Try and piece together information in order to ascertain potential biases.
- From these sources, what can you identify as the arguments for and against the cultivated meat industry?
- What are the most persuasive points made from any one of the articles?
- What evidence do you find most credible? Why?
- What claims are less credible? Why?

3. ASSESSMENT

After discussing and analyzing several of the articles, write a one-page opinion piece explaining your point of view on cultivated meat. You may cite evidence and claims from *Meat the Future* or from reading and analyzing any of the recommended articles.

THE MEAT INDUSTRY KNOWS THAT THEY CAN'T MEET THE DEMAND OF THE PEOPLE. AND IF THE DEMAND FOR MEAT IS GOING TO DOUBLE BY 2050, THERE IS JUST NO METHOD OF PRODUCTION THAT THEY HAVE AT THEIR DISPOSAL NOW THAT WOULD SATISFY THAT HUNGER FOR MEAT.

– DR. UMA VALETI

FOUNDER & CHIEF EXECUTIVE OFFICER
UPSIDE FOODS

ADDITIONAL RESOURCES

ADVOCACY ORGANIZATIONS

The Good Food Institute is a nonprofit organization working internationally to accelerate protein innovation. Go to The Good Food Institute

Cultivated meat eliminates two dangers to human health from industrial farms and agricultural pollution: foodborne illness and antibiotic resistance.

- Go to World Organization for Animal Health to research the impacts of industrial meat production and human health.

POLICY AND LEGISLATION

- Review legislation around the globe addressing factory farming such as
  - US Senate Bill - S.3221 introduced January 21, 2020
- Learn about The Cambridge Declaration of Consciousness
- Read the FDA Public Comment Hearing Report on "Foods Produced Using Animal Cell Culture Technology," July 12, 2018.

ENDNOTES

1 Schwartz, Elliot. Claire Bomkamp. "Introduction to cultivated cultivated meat." Good Food Institute, 13 October 13, 2021, https://gfi.org/science/the-science-of-cultivated-meat/.

2 Szejda, K., Allen, M., Cull, A., Banisch, A., Stuckey, B., & Dillard, C., & Urbanovich, T. (2019). Meat cultivation: Embracing the science of nature. Project Report. Washington, DC: The Good Food Institute. Available at gfi.org/meat-cultivation-project

3 Ibid., p. 3.

4 The U.N.'s Intergovernmental Panel on Climate Change.

5 https://www.gfi.org/files/sustainability_cultivated_meat.pdf, p. 2.

6 Beef production alone is responsible for 25% of all food-related GHG emissions. https://ourworldindata.org/food-ghg-emissions

7 http://www3.weforum.org/docs/WEF_White_Paper_Alternative_Proteins.pdf

8 Hanna L. Tuomisto, Ellis, and Haastrup 2014; H.L. Tuomisto and de Mattos 2011; Mattick et al. 2015.

9 https://www.scientificamerican.com/article/heres-how-much-food-contributes-to-climate-change/

10 https://www.mayoclinic.org/healthy-lifestyle/nutrition-and-healthy-eating/in-depth/meatless-meals/art-20048193

11 https://newrepublic.com/article/158700/inconvenient-lesson-pandemic-stop-eating-meat

12 https://www.wri.org/insights/how-sustainably-feed-10-billion-people-2050-21-charts

13 https://bit.ly/30pKDKp, p. 23.

14 https://sdgs.un.org/#goal_section

15 https://www.nationalgeographic.com/foodfeatures/feeding-9-billion/

16 https://animal.law.harvard.edu/

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25 https://www.theguardian.com/commentisfree/2020/jan/08/lab-grown-food-destroy-farming-save-planet

26 https://thecounter.org/lab-grown-cultivated-meat-cost-at-scale/

27 https://www.forbes.com/sites/errolschweizer/2021/05/06/what-questions-should-we-be-asking-about-cell-based-meats/?sh=12af64636244

28 https://www.nytimes.com/2021/04/24/opinion/climate-change-meatless-meat.html

29 Szejda, K., Allen, M., Cull, A., Banisch, A., Stuckey, B., & Dillard, C., & Urbanovich, T. (2019). Meat cultivation: Embracing the science of nature. Project Report. Washington, DC: The Good Food Institute. Available at go.gfi.org/meat-cultivation-project, p. 13.

APPENDIX I

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https://fortune.com/2016/04/25/memphis-meats-lab-grown-meat/

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Fate of Food. Amanda Little. What We'll Eat in a Hotter, Smarter World.
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APPENDIX II

DISCIPLINES AND STUDIES TO SCREEN *MEAT THE FUTURE*

Agricultural Genetics
Agricultural Science
AI/Machine Learning
Anatomy and Physiology
Animal Science
Automation Engineering/Robotics
Biochemistry
Bioengineering
Bioinformatics/Computational Biology or Science
Biology
Biomaterial Engineering/Biofabrication
Biomedical Science/Engineering
Biomedicine
Bioprocess Engineering
Biotechnology
Cell Biology
Chemical Engineering
Chemistry
Climate Science
Critical Animal Studies
Computer Science
Data Science
Developmental Biology
Earth and Environmental Science/Studies
Ecology
Electrical Engineering
Energy Systems Engineering
Environmental Engineering
Fluid hydraulics / Hydraulic engineering
Food Science
Genomics
Immunology
Manufacturing/Industrial Engineering
Marine Biology
Material Science/Engineering
Meat Science
Mechanical Engineering
Metabolic Engineering
Microbial Biology
Microbiology
Molecular Biology
Nanotechnology
Nutritional Science
Pathology
Pharmacology
Philosophy/Ethics
Plant Science
Statistics
Software Engineering
Synthetic Biology
Tissue Engineering
Veterinary Science
Zoology

APPENDIX III

EXPLAINING CULTIVATED MEAT – NARRATIVE

Excerpted from the Good Food Institute

We can now diversify and strengthen the protein supply by producing meat in a new, more efficient way. Rather than raising and slaughtering animals, we can cultivate meat directly. This starts with the basic building block of all life—the cell.

From a sample of animal cells, we can grow the same beef, pork, poultry, and seafood we enjoy eating today. In conventional animal farming, cell growth occurs in the animal. **But we can grow the same cells in what is known as a cultivator**.

The cultivator facilitates the same biological process that happens inside an animal by providing warmth and the basic elements needed to build muscle, water, proteins, carbohydrates, fats, vitamins, and minerals. **Cultivating meat is similar to growing plants in a greenhouse**.

This new method of meat production enables the natural process of cell growth but in a more efficient environment. **This result is an abundance of cultivated meat, identical to conventional meat at the cellular level but free of pathogens and other contaminants**.

Cultivated meat looks, taste, and cooks the same.

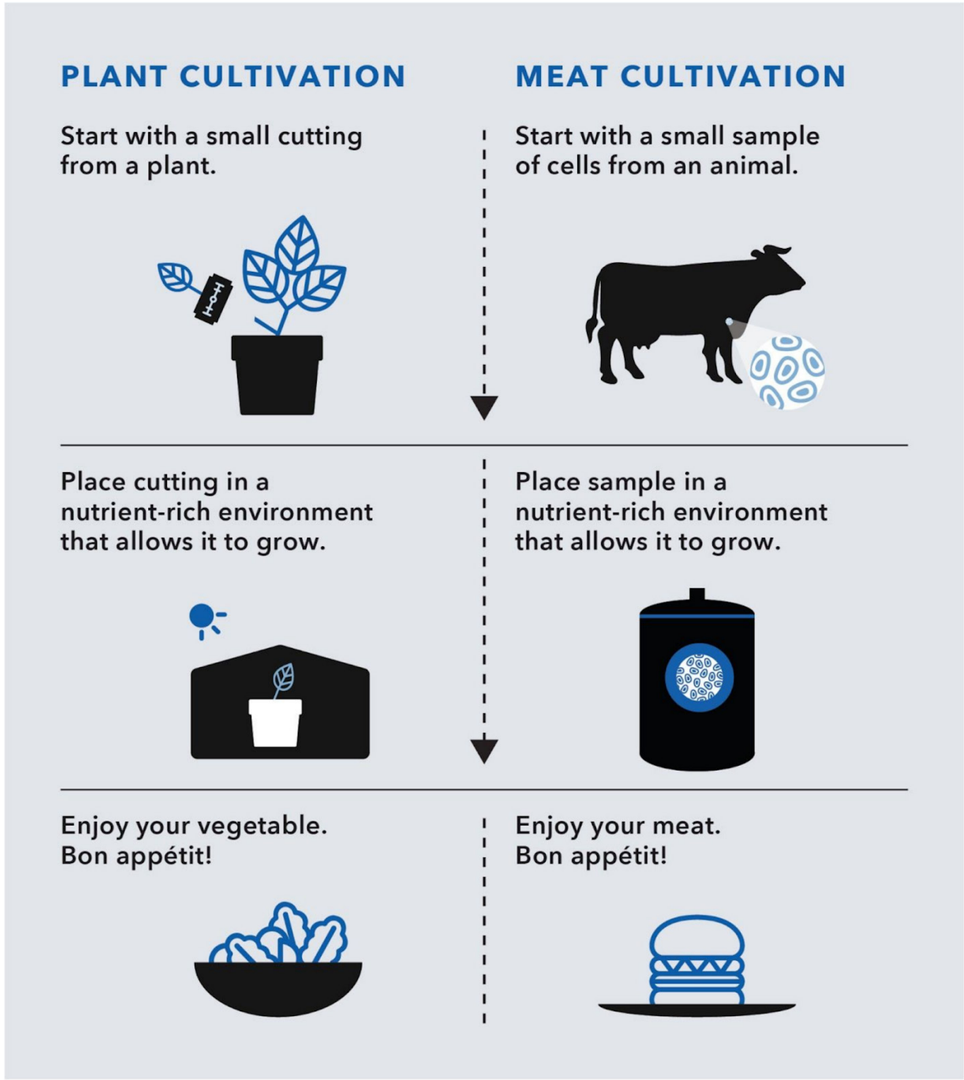
Compared with conventional meat production, meat cultivation is less resource-intensive, decreasing methane emissions, deforestation, biodiversity loss, water use, water pollution, antibiotic resistance, and foodborne illnesses.

Innovators around the world are working to bring cultivated beef, poultry, pork, fish, and seafood to market at a competitive price point. The FDA and the USDA will jointly regulate this new form of meat production in the United States.

Meat cultivation will expand the protein options available to consumers, providing the meat so many people desire, just produced in a new and sustainable way.[29]

APPENDIX III

EXPLAINING CULTIVATED MEAT – GRAPHIC



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