Clean Meat: Did We Under or Over Estimate How Far This New Industry Could Grow?

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Clean Meat: Did We Under or Over Estimate How Far This New Industry Could Grow?

By Tyler Glick

Advisor: Cynthia Sharp-Carr
Date: 04/21/2020

Submitted in partial fulfillment of the requirements of the University Honors Scholar designation at Johnson & Wales University.
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I would like to give thanks and appreciation to the numerous people (and services) who have helped me to succeed. Completing the Honors Program is by far one of the greatest achievements that I have the honor (all puns intended) of having at Johnson & Wales University. It’s a four-year challenge that only a small portion of the university completes to the very end.

First, I would like to thank the Director of the Honors Program Professor Wagner for all of her help with guiding me through the honors program and for helping me with distributing my survey to the other honor’s students. If I am remembering correctly, I was part of Professor Wagner’s first year of students as the Director of the Honors Program. I remember when she stopped by my first Honors Class years ago and she explained the Honors Program to us. It seemed like a feat that I would never be able to accomplish but here I am.

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The last people that I would like to thank is everyone who filled out my survey. If I had asked for the survey takers to provide me with their email I would’ve loved to have emailed a copy of my finalized Honors Thesis to them.

I would like to thank Google for being an amazing search browser and for offering the extremely convenient Google Forms to the public.

I would like to thank the Involvement Network of the Johnson & Wales University Providence, Denver, North Miami and Charlotte campuses. Without the Involvement Network finding the contact information for emailing the presidents and faculty advisors for all the food and environmental related clubs across all four campuses would’ve been extremely difficult.
Chapter I: Abstract

Soon lab-grown meat will be on the market for everyday consumers to purchase, but will it be successful as the companies producing it are predicting? Scholarly discussions on lab-grown meat are in their beginning stages with most attention being directed toward the production process (Kowitt 2017; Mitchell 2017; Schwartz & Conley 2018). The late decade of the 2010’s saw an increasing amount of coverage and interest in lab-grown meat. As the technology continues to advance, I hypothesize that lab-grown meat will become more readily available to consumers; however, I question whether or not consumers are ready for such a change even if it turns out to be both affordable and sustainable. This thesis analyzes results from a longitudinal study conducted from Fall 2018 until Winter 2019-2020. I surveyed a diverse spectrum of people from different origins, ages, income and education levels. These surveys would have to briefly explain what clean meat is. The surveys would then gauge respondents’ opinions of clean meat is and how commonplace they believe clean meat will become in the future to answer the question of how we have changed during this short and exciting time in regards to clean meat. The majority of the results of the data from this survey is inconclusive. Many trends in the data were not able to be formed. Trends show people’s awareness of, readiness for, and eagerness for this product and industry to be decreasing in areas and increasing in other areas. To answer my question posed in the title of this thesis. I believe that I did overestimate how far awareness of, readiness for, and eagerness for this product and industry could grow. I hope that the knowledge
gained from this research supports the future culinary endeavors of not just my fellow students, but culinary professionals across the globe.
Chapter II: Introduction

You, the reader of this thesis, maybe asking and/or saying to yourself "Why did he decide to do his thesis on lab-grown meat? He has got to be a vegan." Surprisingly, this is not the case. There are two classes in the Honors Program in which one works on their Honors Thesis. RSCH 3020 is a class in which students are taught various research and documentation methods. RSCH 4020 is the class in which the thesis is written during the student's time. I was planning on taking RSCH 4020 during my Senior Internship the Last Trimester of my Undergraduate because my Senior Internship and RSCH 4020 don't require me to be at one of the four campuses. I wanted to get RSCH 3020 out of the way during the Spring 2018 Trimester. I didn't know until it was too late that I had to complete a prospectus for my thesis in RSCH 3020 meaning I had to choose my thesis topic in that class. I realized that I had a great opportunity on my hands since there would be about two years between when I was supposed to start my thesis in RSCH 3020 and when it was supposed to end in RSCH 4020. I would be able to complete a longitudinal study using this large gap in time between Spring of 2018 and Winter of 2019-2020. I knew that I wanted to do my thesis on something related to food and thought to myself what in the world of food is going to be changing a lot over the next few years. Lab-grown meat was the answer that eventually came to mind so that is what I chose to pursue. I am not vegan; I would consider myself a Semi-Vegetarian (occasionally will eat meat or fish).

The growing demand for farm-grown meat has caused numerous environmental, economic and social problems. The increasing number of animals that need to be raised
to be slaughtered increases the amount of greenhouse gases released into the atmosphere. The use of farmland disrupts natural ecosystems. The need for the farm-grown meat industry to make goals to continue to keep costs and prices down increases these causes. The way the animal husbandry practices that the farm-grown meat industry goes about achieving their goals leads to more people wanting to eat less meat.

The reason why lab-grown meat has been more talked about is because of its increasing demand. On a basic level, the demand is increasing because of its environmental, economic and social potential. If the lab-grown meat industry causes the farm-grown meat industry to shrink, would there be less greenhouse gas emissions? If the price of lab-grown meat continues to shrink, then at what point will it cause competition for the price of farm-grown meat? If people are more likely to support lab-grown meat over farm-grown meat because of the social implications, then how will that affect the demand for farm-grown meat?

The main question I wish to ask, using a longitudinal study, is how much have we grown or shrunk in terms of three factors: awareness, readiness and eagerness. Those three factors along with the opinions of lab-grown meat are the focus of my analysis. I estimated that due to the projected increase in the prevalence of news and availability about the subject of lab-grown meat, those three factors should have increased along with the opinions of the said subject matter.
Chapter III: Literature Review

Concept:

The term "clean meat" is used interchangeably with "lab-grown meat". The term "clean meat" is used to emphasize that no animal deaths are involved in producing the meat, which was grown in a laboratory. When I try to explain the process of how meat is grown in a lab, most people's reactions are, "How can it be that simple?!?" Biologists take two tissues from an animal, blood, and muscle. (Yes, blood is a tissue (Schwartz, R. S., & Conley, C. L. 2019).) They extract stem cells from the muscle tissue and then the extracted stem cells are encouraged to reproduce in a nutrient-rich, blood-based broth (Mitchell 2017). Next, the cells are combined with a collagen gel, which allows the cells to organize back into muscle tissue. This muscle tissue is what is known as clean meat.

Clean meat has been explored as an alternative to farm grown meat, but it faces obstacles, such as slow production and increased competition from plant-based meat. This is an incredibly slow process that takes months to mature into a small amount of the final product (Mitchell 2017). The average slaughter time for farm-grown meat is: 18 months for beef cattle, 5-6 months for pigs, 7 weeks for broiler chickens and 4-5 months for turkeys (Aussie Farms 2020). On the other hand, lab-grown meat has more competition than just farm-grown meat. The realistic plant-based meat substitute industry is picking up and is already in grocery stores. The L.A. based company Beyond Meat is trying to seize the meat-substitute industry with its products. Beyond Meat is taking the proteins from plant matter and resetting their bonds using heating, cooling, and pressure, so they mimic animal muscle (Kowitt 2017). Plant-based meat and
lab-grown meat will compete in the marketplace in a few years but which will be superior?

**Economics of Lab-Grown Meat:**

The most widely spread statistic about lab-grown meat is that in 2013 the cost of a lab-grown burger was $2,290,000 per kilogram but in 2017 it is $80 per kilogram. So, when will consumers be able to go to Stop & Shop and buy lab-grown meat? There is a demand for meat products not made from meat, but not if lab-grown meat were to enter the market today it would be too expensive to even compete with farm-grown meat or plant-based meat substitutes? Lab-grown meat cannot profit with costs this high and alternatives so much cheaper.

**Social:**

In terms of how people will handle lab-grown meat socially there are numerous ways that people can have different opinions on lab-grown meat. Is meat cruelty-free if there is minimal harm done on an animal? Is lab-grown meat safe? Is lab-grown meat Kosher? If the entire Johnson & Wales University switched to lab-grown meat in a decade would there be an outrage?

**Environmental:**

The biggest reason why companies like Memphis Meats are producing lab-grown meat is that they are responding to consumers’ environmental concerns about farm-grown meat. Lab-grown meat is a far more efficient use of resources of land and water.
“Meat is an ongoing environmental and public health catastrophe. Livestock account for 14.5 percent of greenhouse gas production—more than all transportation combined. As meat demand soars, virgin rainforest gets razed to grow feed, and freshwater sources are diverted from drought-prone regions.”

(Bercovici 2017)

If the human population is going to continue to rise, then our use of resources must become more efficient. There would be a significant decrease in the emission of greenhouse gases if farm-grown meat production would decrease.

**Specific Gaps in Research:**

While there have been studies on the public’s opinions and perceptions of lab-grown meat; a longitudinal study has not been conducted and published. Advancements in the industry are being continuously made and documented. The same can not be said about possible advancements in the public’s awareness, readiness and eagerness for the production and industry. There is the potential to predict the future by understanding the past via a longitudinal study. Longitudinal studies on lab-grown meat may not be thought of as a high priority considering the rate of advancement in the industry but studies like the one I have conducted have the potential to document changes that would otherwise be lost to time forever.
Chapter IV: History

The earliest known records of the idea of lab-grown meat were written in 1931 in *Strand Magazine* by British politician Winston Churchill:

“With a greater knowledge of what are called hormones, i.e. the chemical messengers in our blood, it will be possible to control growth. We shall escape the absurdity of growing a whole chicken in order to eat the breast or wing, by growing these parts separately under a suitable medium. Synthetic food will, of course, also be used in the future. Nor need the pleasures of the table be banished. That gloomy Utopia of tabloid meals need never be invaded. The new foods will from the outset be practically indistinguishable from the natural products, and any changes will be so gradual as to escape observation.” (Churchill 1931)

In 1998 the first patent for lab-grown meat was officially submitted by Jon F. Vein. The abstract of the patent states, “The meat product comprises muscle cells that are grown ex vivo and is used for food consumption. The muscle cells may be grown and attached to a support structure and may be derived from any non-human cells” (Vein 2000). In the 2000s not a lot of progress on the subject was made. Experiments involving lab-grown meat began. The first piece of lab-grown meat that was edible was created in the year 2002, when a bio-engineer at the National Aeronautics and Space Administration (N.A.S.A.) Morris Benjaminson had created edible lab-grown fish from the tissues of a goldfish (Heussner 2011). In the 2010s is when things started to take off. In 2013 the first lab-grown beef hamburger was produced and cooked at a press
conference in London, England. It took years of research estimated to cost around $325,000 to produce the one lab-grown meat patty that was cooked in London (Peters 2018). This success led to companies trying to produce lab-grown meat. In 2015, Memphis Meats, one of the first lab-grown meat companies, was started in Berkeley, California (MemphisMeats.com 2020). Their goals can be seen in their mission statement:

“At Memphis Meats, our mission is to bring delicious and healthy meat to your table by harvesting it from cells instead of animals. You can enjoy the meat you love today and feel good about how it’s made because we strive to make it better for you...and for the world.” (MemphisMeats.com 2020)

In February of 2016 Memphis Meats became the first company to produce a meatball from lab-grown meat. In March of 2017, they became the first company to produce lab-grown poultry (MemphisMeats.com 2020). They have received numerous investments from Tyson Foods, Inc., Bill Gates & Richard Branson (Sorvino 2018). Other countries have entered the ring in a way, such as Israel's SuperMeat company. In late 2018, one of the most recent companies to enter the lab-grown meat industry is the Dutch-based company Meatable (Meatable.com 2020). Meatable believes that they have found a way to produce lab-grown meat without harming animals at all via stem cells (Meatable.com 2020). While other companies are focusing on lab-grown meat & poultry, Finless Foods Inc. in Emeryville, California is focusing on fish and seafood (Finlessfoods.com 2020). Finless Foods Inc. was founded in 2017. As of this writing, none of these companies' products are easily available on the market.
Chapter V: Motivation Theories

Dietary Theories

One of the biggest reasons someone diets is because of health. People’s perceptions of what a diet should consist of are influenced by their culinary and nutritional knowledge (Sanchez-Sabate, Badilla-Briones, & Sabate 2019). For example, the Culinary Arts Program at Johnson & Wales University teaches students about the concepts of meat minimalism and how the Mediterranean Food Pyramid is superior to the American Food Pyramid. Protein is a major part of the human diet, but where that protein comes from makes a difference in one’s diet so much so that meat-related diets are currently commonplace. Meat-centered diets also factor in fat and lipid intake. How much protein is consumed has a major impact on our bodies from aspects such as renal health, heart/artery health, muscle development, cognitive function, etc..

For this thesis, I had split human diets into eleven meat-related diets categories. Omnivore, Vegetarian, Ovo-Vegetarian, Lacto-Vegetarian, Ovo-Lacto-Vegetarian, Vegan, Semi-Vegetarian, Pescatarian, Pollotarian, Pollo-Pescatarian and Other. Omnivore simply means that someone eats everything. The four different levels of vegetarianism are defined by whether the eggs or dairy are included in the diet. Lacto means that diary is included, ovo means that eggs are included and Ovo-Lacto means that both are included. Vegans are those that don’t consume anything produced by animals such as honey or gelatin. Semi-Vegetarian is an in-between diet for people who want to minimize or less the amount of meat that they consume. Pescatarians are vegetarians who consume fish while pollotarians are vegetarians who consume poultry.
Pollo-Pescatarians are sort of a combination of both; they are vegetarians that consume both fish and poultry. Other refers to diets that do not fall into any one of these categories such as Kosher or Halal. These eleven meat-related diet categories are not able to include all combinations of diets.

It is important to point out that people’s diets can change when they want and just because someone states their diet doesn’t mean they have to follow it one hundred percent of the time. Also, some believe that people should not put labels on their diets because some aspects of people should not be categorized. However, these categories, though imperfect, offer a way to process the data from my surveys. I was very lenient on how people identified themselves when processing the data from my survey. A few examples include allowing submissions who said: they were an Omnivore but eats meat zero times per week, they were an Ovo-Vegetarian but eats meat twice a week or they were a Semi-Vegetarian but eats meat 16 times a week.

Social & Ethical Theories

When lab-grown meat hits the public market numerous questions about the social and ethical dilemmas regarding lab-grown meat will be brought to the discussion table. One can imagine that student groups such as the Students for Ethical Treatment of Animals at Johnson & Wales University will be holding intense and controversial panel discussions about what to do now that people have the option to consume lab-grown meat. Based on my surveys I would expect that people who are not omnivores for ethical or social reasons should not be united on the question of whether they should be able to consume lab-grown meat. In terms of the ethical non-omnivores,
the question of eating lab-grown meat can be seen as a bit of a grey area in between eating farm-grown meat and not eating farm-grown meat (Chauvet 2018). One is still eating meat but the meat is not directly from an animal. If someone’s ethical standards for not being an omnivore was because they don’t want animals to be harmed, then lab-grown meat should be ethical to them (Chauvet 2018).

The need for more sustainable meat products has influenced plant-based-meat products such as products made by Impossible Foods to be more prevalent and commonplace in mainstream media. It is interesting to think about how while collecting data for this thesis both Dunkin & Burger King have incorporated Impossible Foods products on their menus and they appear to be here to stay for a long time. Currently, I hope the trend continues to spread to Taco Bell.

One aspect of lab-grown meat that I should address is the part about the blood siphoning that is required for the typical production of lab-grown meat. Lab-grown meat is produced with minimal harm done to the original animal, the keyword being “minimal.” Although some companies such as Meatable claim that they have been able to produce lab-grown meat without blood siphoning the rest of the industry is using blood. The philosophical debate on whether blood siphoning counts as harm, in this case, is still on the table. It may be a question of physical harm or symbolic harm. It is easy to overlook the fact that farm animals are being used to make lab-grown meat although the amount of animal husbandry taking place to produce lab-grown meat is still drastically less than farm-grown meat. The philosophical question of “Does lab-grown meat affect an animal’s dignity?” is one that should be kept in mind (Chauvet
DID WE UNDER OR OVER ESTIMATE HOW FAR THIS NEW INDUSTRY COULD GROW?  

2018). There hasn’t been much research into this very specific topic in terms of a study. It would be interesting to see how more people would process questions about lab-grown meat versus farm-grown meat when farm-grown meat is being directly associated with animal deaths while farm-grown meat is associated with animal use.

Conservationist Theories

The impact that one’s diet has on the environment is a factor of why someone chooses the diet that they follow. The farm-grown meat industry causes water pollution and greenhouse gas emissions and leads to a loss of biodiversity to keep up with the supply and demand of the industry (Zee 2018). Eventually, there will be an environmental bubble-popping of some sorts in which the supply of the farm-grown meat industry will not be able to meet the demand. One study concludes that the more people are aware of how their diets impact the environment the more likely they are to be willing to change their diets. (Sanchez-Sabate, Badilla-Briones, & Sabate 2019)

“Willingness is easily hindered by different reasons and motivations. Therefore, satisfying consumer demands for nutritional and culinary education may significantly increase people’s willingness to help the environment by reducing meat consumption.” (Sanchez-Sabate, Badilla-Briones, & Sabate 2019)

According to the study, environmental reasons for diets are not as common as health or ethics, although my data shows that environmental reasons are most common. People that are made aware of how their diets impact the environment can commonly perceive their individual choice and actions as insignificant, which leads to them being more unwilling to change. Another reason for people commonly being unwilling to change is
that the value of eating farm-grown meat outweighs the value of improving the environment. Global veganism can be seen as an overall final solution to many of the problems caused by the farm-grown meat industry but lab-grown meat by a transitional solution (Sanchez-Sabate, Badilla-Briones, & Sabate 2019).

Economic Theories

The overall greatest reason why lab-grown meat is not yet on the market is the price. Once the price of lab-grown meat shrinks enough to compete with farm-grown then we will start to see it on the market. How much does price contribute to people’s choices of diets? A common reason for people not wanting to change their diets to include less meat is the belief that the time and money needed to compensate for the nutrition from the forgone meat is not worth the change (Reddy 2020). I would think the opposite because of my personal experiences in lowering the amount of meat in my diet. I love going to Restaurant Depot and getting a case of tofu for about 15 dollars and calling it a day. Not everyone is skilled or educated enough to know how to cook tofu without it tasting terrible. People tend to think of vegetarian and/or vegan options as more expensive, which they typically are due to lower sales and demand (Reddy 2020). For example, despite both being equally as delicious, Burger King’s Impossible (planted-based meat) Whopper is around one or two dollars more expensive than their normal farm-grown meat Whopper ( Angerer 2020).
Chapter VI: Secondary Research

The number of peer-reviewed articles and publications about lab-grown meat has been steadily increasing since 2008 but remains low (Fernandes, Fantinel, Leal de Souza & Revillion 2019). This niche of research leads to people citing each other which is not negative. The world of lab-grown meat is frontier all of itself in terms of research.

Tertiary Research

Since Spring of 2018, I was periodically collecting news articles about lab-grown meat to add to my research as a form of tertiary research. Finding new news articles every so often was not difficult in the slightest. A decent percent of these articles simply report on new lab-grown meat companies as they are created such as Future Meat Technologies, Mission Barns Inc., Mosa Meats, New Age Meats, Aleph Farms and Multus Media.

There is an overall trend in those articles that I have collected becoming less skeptical in tone over time. In addition, over time the news articles' predictions of when lab-grown meat will hit the public market have been delayed.

There are some topics in these articles that address concerns that do not fall under the scope of the current thesis, such as: “Meat 2.0? Green meat? War of words over what to call lab-grown meat: 'Clean meat' implies natural meat is dirty, says one beef advocate”, “Lab-grown meat and the fight over what it can be called, explained: Several products are getting closer to market. Missouri now says they can’t be sold as “meat.”” and “Lab-Grown Meat Debate Overlooks Cows' Range of Use Worldwide.” These topics may provide directions for future research.
Economic Research

One of the few publications directly addressing consumers’ views of lab-grown meat I was able to find was a study published in February 2019 by Christopher Bryant, Keri Szejda, Nishant Parekh, Varun Desphande & Brian Tse. Their survey was concluded through a service called CINT and involved 987 respondents from the United States, 1,024 from India and 1,019 from China (Bryant, Szejda, Parekh, Desphande & Tse 2019). The publication focuses on how income and education levels were predictive in the responses for the survey.

The study concluded that those with higher income and education levels in China and India were more likely to want to purchase lab-grown and plant-based meat compared to those in similar demographics in the United States (Bryant et al. 2019). The results for the United States to the question of “How likely are you to purchase clean meat regularly?” was an average of 2.72 out of 5 on a 5-point Likert Scale (Bryant et al. 2019).

Social Research

A November 2016 study by Matti Wilks & Clive Phillips of the University of Queensland in Australia (Wilks & Phillips 2017). The study had a very in-depth online survey about lab-grown meat and used Amazon Mechanical Turk for crowd-working to have American adults complete the survey for fifty cents each (Wilks & Phillips 2017). 673 people completed the survey over a few months. The majority of the survey dealt with the social implications of lab-grown meat.
The questions that were asked in the survey were much more to the point and general compared to my survey. An example question was; “Would you be willing to eat IVM [In-Vitro Meat] as a replacement for farmed meat?” and the possible answers were: “Definitely yes”, “Probably yes”, “Unsure”, “Probably No”, “Definitely yes” and “Not applicable (I do not eat farmed meat)” (Wilks & Phillips 2017). The professors reached numerous small conclusions based on their research instead of one overarching conclusion. Conclusions such as:

“Pescatarians were most likely to perceive IVM to be healthy... and tasty... compared to farmed meat. Vegans perceived IVM as more natural than farmed meat..., and both vegetarians... and vegans... perceived IVM to be more appealing compared to farmed meat. Willingness to try and eat IVM regularly was found to be lowest for both vegetarians... and vegans.... Willingness to eat IVM instead of meat substitutes was also predicted by eating habits, with vegetarians... and vegans... being least willing to eat IVM as a replacement... Vegetarians and vegans were more likely to perceive benefits compared to farmed meat, but they were less likely to want to try it than meat eaters.” (Wilks & Phillips 2017)

The professors found that age was not predictive of any responses to their survey.

Environmental Research

There do not appear to be any peer-review articles or publications on surveys focusing primarily on the opinions of potential benefits or harms of lab-grown meat could have on the environment. However, the study by Professor Matti Wilks & Professor Clive Phillips has data on the subject. The following are questions and the
averages out of a 5-point Likert Scale with 1 being “much more” or “strongly agree” and 5 being “much less” or “strongly disagree” (Wilks & Phillips 2017):

- How environmentally friendly do you think IVM is compared to farmed meat? --- 1.97,
- IVM is disrespectful to nature. --- 3.69
- IVM will be able to solve world famine problems. --- 2.53 &
- IVM will reduce the impact of global warming associated with farming. --- 2.55.
Chapter VII: Methodology

Research Method

The survey for this thesis was done in three rounds, the first round being between 10/23/2018-11/8/2018. The second round was split between two different periods, 3/19/2019-4/15/2019 and 6/1/2019-6/14/2019. In order to get a sufficient number of respondents. The last round took place between 12/4/2019-12/24/2019. The first round consisted of 144 participants, second round 105 participants and the final round 72 participants. If one splits the second round the number of participants the first part was 65 and the second half was 40.

My survey was shared via multiple methods. The methods that were utilized consistently were having an email be sent to all current Honors Students at Johnson & Wales University and emailing the presidents and faculty advisors for all the food and environmental related clubs across the Providence, Denver, North Miami & Charlotte campuses for Johnson & Wales University. These emails encouraged recipients to share the survey with other people. I also used social media websites such as Facebook and Reddit’s r/SampleSize & r/Assistance in all three rounds. For the second part of the second round, I used the websites surveycircle.com and surveyswap.io to get most of the participants quickly. SurveyCircle allows one to donate money to a charity to set one's survey apart from others. I donated $15 to the Make-A-Wish Foundation.

The surveys had a total of 20 questions. The first four questions of the survey asked basic demographic questions: age, gender, ethnicity, and education. The fifth question asked which of the eleven meat-related diets discussed previously is followed
by the respondent. Explanations of each of the diets were provided. If the participant was not an omnivore then their reasons for not being an omnivore were surveyed in the sixth question. The seventh question asked "On average, how many times a week do you eat a home-cooked meal?" while the eighth question asked, "On average, how many times a week do you eat meat?" Questions 9, 10, 12, 13, 14, 19 and 20 used a five-point Likert scale, ranging from strongly disagree to strongly agree, very concerned to very unconcerned and very likely to very unlikely. The questions in order were:

9) How likely or unlikely are you to consume lab-grown meat if you, a parent/guardian or friend were the one that cooked it?

10) How likely or unlikely are you to consume lab-grown meat if it was cooked in a restaurant?

12) Do you agree or disagree that people who are vegetarian for environmental reasons should be able to consume lab-grown meat?

13) Do you agree or disagree that people who are vegetarian for ethical reasons should be able to consume lab-grown meat?

14) Do you agree or disagree that people who are vegetarian for cultural or religious reasons should be able to consume lab-grown meat?

19) Are you concerned or unconcerned about any unforeseen consequences with lab-grown meat?

20) Do you agree or disagree with the following statement? "Lab-grown meat is going to be nothing more than a short lived fad."
Question 11 asked "What factor of the lab-grown meat would be the most important to you?" with the possible choices being: texture, smell, appearance and taste. The remaining four questions are where most of the data analytics will be utilized.

15) What is your personal average food budget per week? (Answer in $X.YZ)

16) Compared to farm-grown meat, how much more would you be willing to pay for lab-grown meat? (Answer in XY%)

17) In how many months would you guess lab-grown meat will be on the market for people to purchase and consume? Please use Arabic Numerals. (ex: 1, 2, 3, etc).

18) How much per pound do you believe lab-grown meat currently costs? (Answer in $X.YZ)

The preface for the survey can be found below:

“You are invited to participate in a web-based online survey about Lab-Grown Meat. This is a research project being conducted by Tyler Glick, a student at Johnson & Wales University. It should take approximately 5 minutes to complete.

Your participation in this survey is voluntary. You may refuse to take part in the research or exit the survey at any time without penalty.

Your survey answers will be sent to a link at Google Forms where data will be stored in a password protected electronic format. Google Forms does not collect identifying information such as your name, email address, or IP address. Therefore, your responses will remain anonymous.”
If you have questions at any time about the study or the procedures, you may contact my research supervisor, Professor Cindy Sharp via email at cindy.sharpcarrd.v.m@jwu.edu.

Introduction:

The term “clean meat” is used interchangeably with “lab-grown meat.” The explanation for the term “clean meat” is to emphasize that there are no animal deaths being used to produce the meat that was grown in a laboratory. Lab-grown meat is made when biologists take two tissues from an animal: blood and muscle. They extract stem cells from the muscle tissue and then the extracted cells are encouraged to reproduce in a nutrient rich, blood-based broth (Mitchell 2017). Next the cells are combined with a collagen gel, allowing the cells organize back into muscle tissue. This muscle tissue is what is known as clean meat. It is an incredibly slow process that takes months to mature into the final product (Mitchell 2017). Soon lab-grown meat will be on the market for everyday consumers to purchase.”

Data Processing

Before processing the data I had received from my survey I had to remove any invalid participants that were not serious when completing the survey, such as someone who eats 40 meals in a week, believes that lab-grown meat costs $0 and would be willing to pay -99% more to buy lab-grown meat over farm-grown meat. Due to this thesis being for adults only, four participants that said they were 17 years old had to be removed. Any participants that answered with profanity were removed. The numbers
after this process were 139 (-5) for the first round, 103 (-2) for the second round and 70 (-2) for the last round.

Any answers that weren’t in USD such as CAD, Euros and UK Pounds were converted via databases on 12/28/2019 via travelex.com. (travelex.com, 2019) Answers that were in ranges were edited to be the median of the range. Answers that weren’t in the correct format were edited to be more homogeneous with the other submissions. For example, “Very low, I get free food at work” would be changed to $0 or “I wouldn’t buy this at all” would be changed to N/A.

The graphs for all twenty questions can be found in Appendix A. The majority of the data was processed and graphed by the three rounds and by the entire results of the survey.

The data that has been filtered in some way can be found in Appendix B onwards. Trends in the correlation between one part of the data that was submitted and the round it was submitted were uncommon. Trends in the correlation between two or more parts of data and the round it was submitted were more common when alterations were made. Alterations, such as separating Meat-Eaters from Non-Meat-Eaters or separating people in groups above or below the median age. When I use the term "Meat-Eaters" that is referring to those answered to Omnivore, Semi-Vegetarian & Other from question five being "What diet do you follow?" Meat-Eaters represented around three-fourths of the entire survey. The Meat-Eater Data can be found in Appendix B. Data by the median of age can be found in Appendix C.
Appendix D is data that used to show how Non-Omnivores for various reasons think of their diets in regards to lab-grown meat. This uses the data from Question # 6. Appendix E is miscellaneous data that doesn’t fit into the previous appendixes.

The demographics that I decided not to analyze for the thesis were: gender, ethnicity & education. In terms of gender, the data showed that 70% of the people who filled out the survey were female so the information I could extract from separating females from the other submissions would most likely not show any accurate trends and/or correlations. A similar story can be said about ethnicity since over three-fourths of submissions were from respondents who identified as white. As for education, if the ratio of education levels were more consistent across the three rounds, as the ratio of Meat-Eaters to Non-Meat-Eaters, then I would feel comfortable separating data submissions into education groups. If I could put a quantitative value on education, such as I did with age, then I could separate the education results into quartiles.

There are some factors that I wish I could analyze from my data but unfortunately can't due to the way I collected the data not being consistent and significant enough for an accurate analysis. For example with Question # 7, there were a lot of responses saying that they have a meal plan through their university and/or that they don't currently have access to a kitchen to cook in since they live in a dorm. With Question # 8, I should have elaborated more on the question in the survey. I should've made the question; "On average, how many times a week do you eat meat as a main component of a meal?" The phrase “eat meat” is broad enough to mean that eating jerky
at the gym counts as eating meat. The average across those top 10 highest submissions for the question is 18.5 with a range between 16 and 35.
Chapter IX: Findings

Economic Research

Probably one of the most conclusive finds from my survey was that the average estimated price of lab-grown meat did decrease over the rounds. From $38.67 to $26.44 to $24.44.

Looking at the data for the Meat-Eaters some of the economic questions didn’t seem to change much. The difference between the average weekly food budget for Meat-Eaters and the survey as a whole was only $3 more for Meat-Eaters only. This difference may seem low but considering that Non-Meat-Eaters represent only a quarter of the survey as a whole and that are bringing the overall total average down by $3 means that on average they are spending $9 less per week than Meat-Eaters. Multiply $9 by 52 and that number becomes $468 per year. For Question # 16 there was no trend looking at the rounds. The difference between the overall average for Meat-Eaters and the survey as a whole was 2.5% which using the same math as before means that Non-Meat-Eaters on average would be willing to pay 7.5% more compared to Meat-Eaters. Surprisingly the difference between the average response for Question # 18 was only $0.75 for Non-Meat-Eaters and Meat-Eaters.

When separated by the age median, As expected, the average food budget per week was 2.25 times more than those above the median compared to those below the median. This was expected because in general, those that are older have more income and therefore can spend more on food. For Question # 16, I was expecting that those under the median would be more willing to pay for lab-grown meat than those above the
median but the difference between the two groups was only about a fifth of a percent. On average those below the median age guessed that lab-grown meat was half as expensive as those above the median.

Social Research

When comparing the results of Question #9 & #10 it is easy to see that people are more likely to consume lab-grown meat if it was cooked in a restaurant compared to if it was cooked by a parent, guardian or friend. This does show that people have much trust in professionals in regards to preparing lab-grown meat. Comparing the rounds, there is a consistent trend that people are becoming more likely to consume lab-grown meat in restaurants. The trend for if the lab-grown meat was cooked by a parent, guardian or friend is less consistent. Looking at the data for Question #17 there is a trend that people believe that it will take a longer amount of time for lab-grown meat to come to the public market. The average for this question in terms of months went from 14.77 to 22.8 to 24.64.

Looking at the data for Meat-Eaters there is an increasing trend in regards to if the meat was prepared in a restaurant as well as a parent, guardian or friend. There is an increasing trend for how much people agree with allowing vegetarians for ethical, cultural or religious reasons to consume lab-grown meat. The data for the last question didn’t change much when the data was separated by Meat-Eaters. Comparing the Non-Meat-Eater data to the Meat-Eater data shows that Non-Meat-Eaters were less receptive to lab-grown meat in terms Questions #9 & #10.
The data split between the age medians shows that those above the median on average eat 1.5 more home-cooked meals. Age did not play a factor in how often one would consume meat. The data was very consistent. I was expecting that those above the median would consume more meat than those below the median. In regards to both the question about if the meat was prepared in a restaurant as well as by a parent, guardian or friend there is a slight upward trend in positivity for those below the median and a slight downward trend for those above the median. On average those below the median believed that lab-grown meat would be available on the market eight months sooner than those above the median.

The data for Question #11 was oddly consistent even despite separating the data from the Meat-Eaters. When the data was separated by the age median it showed that those above the median believed that taste was a more important factor than those below and the reverse can be said about the texture factor.

Unfortunately, only a total of seven people put down that they weren't an omnivore for cultural and/or religious reasons so my findings of how people in that demographic responded to Question #14 are not significant. For that tiny group the self-tolerance did increase drastically over the rounds. The data for non-omnivores for ethical reasons is thankfully much more significant but still inconclusive. In terms of people in that demographic responding to Question #13, the data is inconclusive.
Environmental Research

Looking at the data for Meat-Eaters there is an increasing trend in regards to Question #12. The data for Question #19 & #20 did not change much when the data was separated by Meat-Eaters. The data is very much still inconclusive.

The split in the data between the age medians shows that there is a slightly increasing trend for Question #12 for both demographics. The data for Question #19 & #20 did not change much when the data was separated by the age medians. The data for Question #19 & #20 is very much still inconclusive.

Being non-omnivore for environmental reasons was the most common reason.

In terms of people in that demographic responding to Question #12, the data is inconclusive.
Chapter IX: Discussion

To answer my question posed in the title of this thesis. I believe that I did overestimate how far awareness of, readiness for, and eagerness for this product and industry could grow. The ratio of inconclusive data to conclusive data that I found was a little bit disappointing to me. For every bit of completely conclusive data that showed that the numbers of people were increasing in awareness, readiness and eagerness there was a bit of data that showed people decreasing in another aspect. The data showing the estimated average price of lab-grown meat decreasing from $38.67 to $26.44 to $24.44 shows an increase in people’s awareness of the decreasing price of lab-grown meat. The average estimate of how many months until lab-grown meat is on the public market increasing from 14.77 to 22.8 to 24.64 shows a decrease in people’s eagerness. When I separated the data by demographics more conclusive data was able to be drawn. I expected that those below the age median in my survey would think that lab-grown meat would be on the public market soon than those above the age median. The data shows that to be true. In this context, it shows those below the age median’s greater eagerness for lab-grown meat to be on the market compared to those above the age median in that regard. One piece of data that had an upward trend that was expected was that Meat-Eaters would be more lenient with allowing vegetarians for ethical, cultural or religious reasons to consume lab-grown meat than Non-Meat-Eaters. I had expected that Meat-Eaters would think that vegetarians would be more lenient than they actually were. The majority of Non-Omnivores chose their diets for more than just one reason.
Some of the data that I got was the opposite of what I expected. The difference between Non-Meat-Eaters & Meat-Eaters for Question # 16 being that Non-Meat-Eaters would be willing to pay 7.5% for lab-grown meat over farm-grown meat compared to Meat-Eaters was unexpected. Since Non-Meat-Eaters were less receptive to lab-grown meat for Questions # 9 & # 10 I thought that Non-Meat-Eaters would want to pay less compared to Meat-Eaters not more. Although this could relate to the economic belief that diets with less meat are more expensive (Reddy 2020). Non-Meat-Eaters could just be more willing to pay for their food compared to Meat-Eaters even though based on my data they pay $9 less per week.
Chapter X: Limitations of the Study

There were some obstacles I needed to overcome my research. Since I started this adventure in the Spring of 2018 a decent amount of things have changed in terms of the Honors Program since when I started. JWU began an Institutional Research Board (I.R.B.) which oversees research methods for both students and faculty to ensure that all human subjects are treated ethically. My Thesis Advisor Professor Sharp & Honors Director Professor Wagner acted as an I.R.B. for me, which led to complications in my original plans.

I was expecting more of the data from the last part of the second round of surveys to be invalid due to relying on surveycircle.com and surveyswap.io but was surprised to see that only two were invalid. I could have made some sort of security system for my Google Form so that people would not be able to submit multiple submissions. My thought process was that using Google Emails as a security system would make completing the survey too cumbersome.

There were two small edits that I had to make to the surveys during the first round. The first edit was simply adding “Other (Kosher, Halal, etc.)” as a choice to the fifth question which asked the participants about their diet. The second edit was adding “Cultural” to the sixth question which asked the participants why they weren’t omnivores. This was due to requests from people who looked at the survey but felt that the survey needed to be changed to include them.

One hindsight for my survey was that in the context of my survey I never defined what “meat” is and is not. The definition that I was using and assuming that other
people would have is that meat in the context of the survey was referring to red meat such as beef, pork & lamb. I do reference red meat in the description of what a Pollo-Pescatarian is for Question # 5. There were a few Pescatarians/Pollotarians/Pollo-Pescatarians that had a high number for how many times per week they consumed meat but I couldn’t do much about it if I failed to properly define what “meat” is and is not. I should have been more clear on what “meat” is and is not but I think my thought process at the time was that I didn’t want to make the survey any harder to complete than it was.

I must acknowledge the possible bias that can come from having my survey be distributed in a personal method. Although it is very convenient, sharing my survey with friends and family is not the most scientifically accurate method of data collection. If someone were to know of me personally, then it could affect how they completed my survey. I would hope that they would not be affected. I think some people who wanted me to succeed in my thesis would have answered differently if the survey was given by a stranger as opposed to me. Having Johnson & Wales University students be the primary target for my survey can also have the same effect. Distributing my food-based survey at a university where around half of the students are either in a Hospitality or Food Service Program does not help the bias either. The opinions of the demographic of these students are not the average of the United States but it was what I had available to me. If I had more resources I would have tried to make the survey distribution less personally and locally influenced.
Chapter XI: Suggestions for Further Research

If I were to redo this entire adventure there would be some changes. I would try more aggressively to get respondents for my survey. I would probably have changed some of the questions had I have known how inconclusive many of them would be. I should have made the survey easier to complete as a whole.

I hope to make the survey results public in some form when my thesis becomes public. Perhaps someone will be able to use my data in a way I wasn’t intending on.

As always more research should be done on the topic of lab-grown meat. The number of studies is going to increase as the topic becomes more prevalent. I still can’t wait for the eventual day that lab-grown meat can be grown at Johnson & Wales University.

Some topics and questions appeared while researching for this thesis that I didn’t want to include in this thesis because of length considerations. These topics include:

1. If eating lab-grown animal meat is ethically sound then is eating lab-grown human meat ethically sound too?
2. What is the best name for lab-grown meat?
3. How would the lab-grown meat industry impact the positive ways that the farm-grown meat influences society through the byproducts of farm-grown meat such hides, bone meal & gelatin?
4. How is lab-grown meat going to be inferior taste or texture wise to farm-grown meat considering aspects in farm-grown meat such as fat deposition, muscle activity and age?
It would be interesting to see how thesis topics and questions are answered in the near future.
Chapter XII: Conclusion

I am a little disappointed in the results of this study but in reality, I should not be at all. I took a huge bite out of a still developing cookie of sorts, and I did the best I could. A part of me knew that I probably would not have enough “ground-breaking” data from this research for it to be very significant to the overall field of lab-grown meat. This thesis has at least added some insights to the developing field of lab-grown meat so I am satisfied with that accomplishment. I am pretty sure this is the first longitudinal-research based thesis from the Honors Program so I hope my work will be an inspiration to other Honor students at Johnson & Wales University.
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DID WE UNDER OR OVER ESTIMATE HOW FAR THIS NEW INDUSTRY COULD GROW?


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https://www.meatable.com/

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DID WE UNDER OR OVER ESTIMATE HOW FAR THIS NEW INDUSTRY COULD GROW?


DID WE UNDER OR OVER ESTIMATE HOW FAR THIS NEW INDUSTRY COULD GROW?


Appendix A

Average Age

Gender Percent
DID WE UNDER OR OVER ESTIMATE HOW FAR THIS NEW INDUSTRY COULD GROW?

Race Percent

Education Percent
Did we under or over estimate how far this new industry could grow?

**Diet Percents**

- Omnivore
- Vegetarian
- Ovo-Vegetarian
- Lacto-Vegetarian
- Ovo-Lacto-Vegetarian
- Vegan
- Semi-Vegetarian
- Pescatarian
- Pollotarian
- Pollo-Pescetarian
- Other

**7&8) On average, how many times a week do you eat...**

- a home-cooked meal?
- meat?
9) How likely or unlikely are you to consume lab-grown meat if you, a parent/guardian or friend were the one that cooked it?

10) How likely or unlikely are you to consume lab-grown meat if it was cooked in a restaurant?
11) What factor of the lab-grown meat would be the most important to you?

- Taste
- Smell
- Appearance
- Texture

12) Do you agree or disagree that people who are vegetarian for environmental reasons should be able to consume lab-grown meat?

- Strongly Agree
- Agree
- Neutral
- Disagree
- Strongly Disagree
13) Do you agree or disagree that people who are vegetarian for ethical reasons should be able to consume lab-grown meat?

14) Do you agree or disagree that people who are vegetarian for cultural or religious reasons should be able to consume lab-grown meat?
15) What is your personal average food budget per week?

16) Compared to farm-grown meat, how much more would you be willing to pay for lab-grown meat.
17) In how many months would you guess lab-grown meat will on the market for people to purchase and consume?

18) How much per pound do you believe lab-grown meat currently costs? (All Data Average)
DID WE UNDER OR OVER ESTIMATE HOW FAR THIS NEW INDUSTRY COULD GROW?

18) How much per pound do you believe lab-grown meat currently costs? Minus Submissions that were over ($1,000)

19) Are you concerned or unconcerned about any unforeseen consequences with lab-grown meat?
20) Do you agree or disagree with the following statement? "Lab-grown meat is going to be nothing more than short-lived fad."
Did we under or over estimate how far this new industry could grow?

Appendix B

Meat-Eaters compared to total Results Data

<table>
<thead>
<tr>
<th></th>
<th>Meat-Eaters</th>
<th>Total</th>
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<td>Round 1</td>
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<td>Round 2</td>
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<tr>
<td>Total</td>
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</table>

7&8) On average, how many times a week do you eat... (Meat-Eaters Only)

<table>
<thead>
<tr>
<th></th>
<th>a home-cooked meal?</th>
<th>meat?</th>
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<tbody>
<tr>
<td>Round 1</td>
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<td>Round 2</td>
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<td>Round 3</td>
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<tr>
<td>Total</td>
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</table>
9) How likely or unlikely are you to consume lab-grown meat if you, a parent/guardian or friend were the one that cooked it? (Meat-Eaters Only)

10) How likely or unlikely are you to consume lab-grown meat if it was cooked in a restaurant? (Meat-Eaters Only)
11) What factor of the lab-grown meat would be the most important to you? (Meat-Eaters Only)

12) Do you agree or disagree that people who are vegetarian for environmental reasons should be able to consume lab-grown meat? (Meat-Eaters Only)
13) Do you agree or disagree that people who are vegetarian for ethical reasons should be able to consume lab-grown meat? (Meat-Eaters Only)

14) Do you agree or disagree that people who are vegetarian for cultural or religious reasons should be able to consume lab-grown meat? (Meat-Eaters Only)
15) What is your personal average food budget per week? (Meat-Eaters Only)

16) Compared to farm-grown meat, how much more would you be willing to pay for lab-grown meat. (Meat-Eaters Only)
17) In how many months would you guess lab-grown meat will be on the market for people to purchase and consume? (Meat-Eaters Only)

18) How much per pound do you believe lab-grown meat currently costs? (Meat-Eaters Only)
DID WE UNDER OR OVER ESTIMATE HOW FAR THIS NEW INDUSTRY COULD GROW?

Not including answers over $1,000 (Meat-Eaters Only)

19) Are you concerned or unconcerned about any unforeseen consequences with lab-grown meat? (Meat-Eaters Only)
20) Do you agree or disagree with the following statement? "Lab-grown meat is going to be nothing more than short-lived fad." (Meat-Eaters Only)
DID WE UNDER OR OVER ESTIMATE HOW FAR THIS NEW INDUSTRY COULD GROW?

Appendix C

7&8) On average, how many times a week do you eat... (By Age Median)

9) How likely or unlikely are you to consume lab-grown meat if you, a parent/guardian or friend were the one that cooked it? (Age Median)
10) How likely or unlikely are you to consume lab-grown meat if it was cooked in a restaurant? (Age Median)

11) What factor of the lab-grown meat would be the most important to you? (Age Median)
12) Do you agree or disagree that people who are vegetarian for environmental reasons should be able to consume lab-grown meat? (By Median Age)

13) Do you agree or disagree that people who are vegetarian for ethical reasons should be able to consume lab-grown meat? (By Median Age)
14) Do you agree or disagree that people who are vegetarian for cultural or religious reasons should be able to consume lab-grown meat? (By Median Age)

15) What is your personal average food budget per week? (By Median Age)
16) Compared to farm-grown meat, how much more would you be willing to pay for lab-grown meat. (By Median Age)

17) In how many months would you guess lab-grown meat will be on the market for people to purchase and consume? (By Median Age)
DID WE UNDER OR OVER ESTIMATE HOW FAR THIS NEW INDUSTRY COULD GROW?

18) How much per pound do you believe lab-grown meat currently costs? (By Median Age)

18) How much per pound do you believe lab-grown meat currently costs? (By Median Age) Not including answers over $1,000
19) Are you concerned or unconcerned about any unforeseen consequences with lab-grown meat? (By Median Age)

20) Do you agree or disagree with the following statement? "Lab-grown meat is going to be nothing more than short-lived fad." (By Median Age)
Appendix D

Reasons for not being omnivores

Environmental  Ethical  Cultural or Religious  Medical

Non-Omnivores for Environmental Reasons who agree or disagree that people who are vegetarian for environmental reasons should be able to consume lab-grown meat?

Strongly Agree  Agree  Neutral  Disagree  Strongly Disagree
DID WE UNDER OR OVER ESTIMATE HOW FAR THIS NEW INDUSTRY COULD GROW?

Non-Omnivores for Ethical Reasons who agree or disagree that people who are vegetarian for ethical reasons should be able to consume lab-grown meat?

- **Strongly Agree**
- **Agree**
- **Neutral**
- **Disagree**
- **Strongly Disagree**

Non-Omnivores for Cultural or Religious Reasons who agree or disagree that people who are vegetarian for cultural or religious reasons should be able to consume lab-grown meat?

- **Strongly Disagree**
- **Neutral**

---

**Round 1**

**Round 2**

**Round 3**

**Total**
Appendix E

9) How likely or unlikely are you to consume lab-grown meat if you, a parent/guardian or friend were the one that cooked it? (Non-Meat-Eaters Only)

10) How likely or unlikely are you to consume lab-grown meat if it was cooked in a restaurant? (Non-Meat-Eaters Only)