The Evolution of What We Eat (Or Who We Are): An Analysis of The Past, Present, and Future of Meat

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Abstract

Food is ensconced into who we are and what we believe—it echoes our culture, our values, and our philosophies. This is especially true of meat, where its production and consumption are tied to religious ideologies, gender roles, and political beliefs. In America specifically, meat is an archaic symbol of power, dominance, and masculinity, causing this staple food to have drastically increased in consumption over the past decades.

However, today's industrial meat production is resource-intensive, causes animal suffering, is linked to several public health issues, and is one of the leading causes of anthropogenic methane emissions. With ten billion people inhabiting our world in 2050, we simply do not have enough arable land or resources to continue the current model of meat production. Thus, a novel, alternative form of meat is essential. Cultured meat, built upon the development of biotechnology, may enable humanity to feed its growing population while avoiding climate catastrophes and food insecurity.

In this paper, I discuss the feasibility of cultured meat—otherwise known as "cultivated," "lab-grown," or "clean" meat—and analyze whether the *culture* of cultured meat can overcome the *culture* of conventional slaughtered meat. I will first discuss America's historical relationship with meat through a theological, sociological, and political lens. Then, I will address the challenges and opportunities of implementing cultured meat into daily life from a technological, political, and rhetorical perspective. I will conclude with an examination of humanity's historical innovation of food and how such innovations have led to greater movements in humankind, arguing that cultured meat is an imminent continuation of Agricultural Revolutions. Ultimately, I argue that peoples' inclination to use technology to upend conventional structures will enable the widescale adoption of cultured meat, consequently shifting our historical relationship with and perception of meat.

Introduction

It is in the presence of food where my family's instability and battles suddenly dissipate. It is as if the mere act of gathering around a table to share in the act of eating renders prior history meaningless and the current moment timeless. It is in the presence of food where my eldest brother Noah told Dad he loved him after several years of not communicating; where Mom sat next to Dad without a lawyer by their side; where my family has gathered at the same hibachi restaurant since I was four years old. But beyond just my family, food is linked to some form of importance—some story, memory, and feeling of nostalgia—in all. Food is ensconced in our evolution, our history, and our global movements.

During the hunter-gatherer era, what we ate was linked to what we could forage and kill; The First Agricultural Revolution enabled humans to cultivate species and livestock; Theism dictated certain foods that could be eaten, and which could not. Imperialism spread cuisines, cooking rituals, and traditions across the globe. Now, we are at a point in our history where what we eat represents our social values and the issues that exist in the world around us—a moment where food and activism go hand-in-fork. But the current food movement is diametrically opposed to our cultural tradition to consume meat.

Our distant sapient ancestors—*hominins*—first consumed meat 2.6 to 2.5 million years ago after the Earth underwent a period of significant warming and drying (Roos, 2019). This environmental change caused early humans to increasingly include a new source of energy in their traditional fruits and vegetable diet: animal carcasses. The addition of meat to the human diet was a critical driver of human evolution: the Expensive Tissue Hypothesis, introduced by Leslie Aiello in 1992, argues that as humans began to eat more meat—a high-energy source of calories that does not require a large intestinal system—brain size increased over time with corresponding reductions in gut size, allowing more energy to be available for fueling a larger brain (Huang et al., 2018; Ireland, 2008). But while the original consumption of meat enabled humans to develop larger brains (and thus intelligence) and socialize and participate in the act of politics, human's current obsession with meat has caused drastic negative implications on our planet.

Today's industrial meat production is resource-intensive, causes animal suffering, and is linked to several public health issues such as animal-transmitted pandemics and antibiotic resistance (Bryant, 2020); Furthermore, one of the most inefficient ways of feeding humans is through conventional meat production—it is a black hole for resources (Kurzgesagt, 2018). Twenty-six percent of Earth's total land area and 27% of global freshwater consumption is used to produce meat; further, producing one kilogram of steak requires twenty-five thousand kilograms of grain and uses up to fifteen thousand liters of water (Kurzgesagt, 2018).

Most importantly, the industry has far-reaching negative environmental impacts, contributing to greenhouse gas emissions and

global warming (Bryant, 2020). Tad Friend (2019), a contributor for *The New Yorker*, notes that "if cows were a country, their emissions would be greater than all the EU, and behind only China and America". Specifically, animal agriculture accounts for 32% of anthropogenic methane emissions and 15% of total greenhouse gas emissions—as much as all planes, ships, trucks, and cars combined (McArthur, 2021; Kurzgesagt, 2018). And because methane degrades much more rapidly and traps eighty times more heat than carbon dioxide, actions taken to decrease methane emissions can have almost an immediate cooling effect on the global temperature, something necessary if we want to limit global warming to 1.5 degrees Celsius (as noted in the Paris Agreement) (Ainger, 2021).

Further, with the global population expected to rise to ten billion by 2050, we can expect to require a 70% increase in total food production to fulfill the demand of this growing population, and specifically, meat demand will increase 73% (Chriki et al., 2020; Bryant et al., 2019). Thus, the negative environmental consequences of industrial agriculture will drastically increase if we do not adopt an alternative protein into our habitual, cultural diet.

With recent breakthroughs in biotechnology, we have a unique opportunity to utilize technology to create modernized meat—to not only restructure our evolutionary diet but to create a tangible impact on our climate through the meat we eat.

Cultured meat may be the technological medium in which methane emissions subside and our historical relationship with meat fundamentally shifts. Cultured meat is real meat grown outside of an animal's body and inside a large-scale bioreactor; it is cellularly identical to conventional meat but without the environmental resources or slaughter required to produce conventional meat (Figure 1). Compared to the conventional production of beef, sheep, pork, and poultry, cultured meat could result in 78-96% less greenhouse gas emissions, 99% less land use, 92-96% less water use, and 7-45% less energy use (Stephens et al., 2018). Notably, cultured meat differs from plant-based meat in that it is produced from animal cells rather than plant-based ingredients. As a result, its taste, texture, and structure mirror that of conventional meat, which is essential for wide-scale adoption and global impact. Thus, it appears a viable, Earth-friendly alternative to conventional meat is at our fingertips, ripe to disrupt and displace many people consume and perceive meat.

But to create a novelty food—particularly one as evolutionarily integral as meat—and distribute it globally and equitably requires tremendous considerations in disciplines such as anthropology, psychology, science, policy, and economics. Previous literature analyzes the efficacy of cultured meat through the lens of scientific obstacles at mass production, the role of rhetoric and nomenclature in shaping and influencing government regulation, and the influence of sociocultural context and tradition on shaping consumers' perceptions of an unfamiliar staple. While I acknowledge these are noteworthy considerations when

discussing cultured meat's ability to displace conventional meat, I believe a gap in current dialogue exists in discussing cultured meat's displacement of conventional meat. Hence, using American culture as a case study, I argue that humankind's inclination to use technology to upend conventional structures will enable the widescale adoption of cultured meat, consequently shifting our historical relationship with and perception of meat.

To develop my thesis, I will first provide background on America's historical relationship with meat from a theological, sociological, and political perspective. Thereafter, I will address the challenges and opportunities of implementing cultured meat into daily life. I will conclude with strategies to facilitate a shift away from our historical relationship with meat as well as an examination of how the use of technology in meat is a necessary continuation of Agricultural Revolutions.

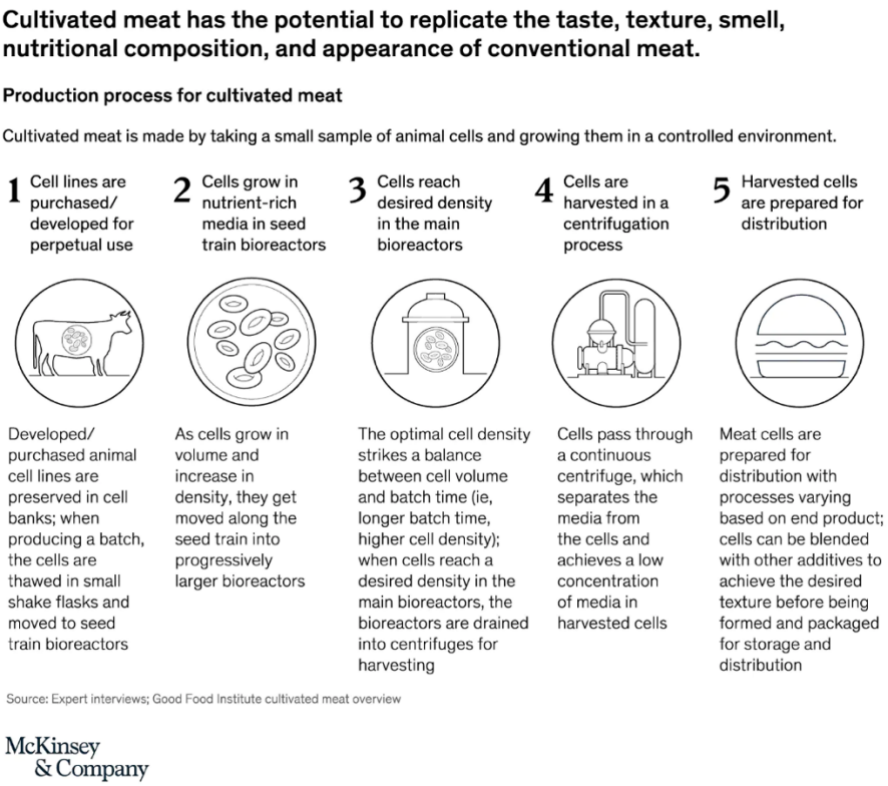

FIGURE 1. The Production Process of Cultured Meat. Reprinted from McKinsey & Company, 2021.

American Identity and Meat

For every culture, foodways[1] connote meaning beyond just a primary source of nutrition; it is a method of communication, a microcosm of the

[1] Foodways is defined as "the eating habits and culinary practices of a people, religion, or historical period" (Merriam-Webster).

greater culture itself. Cultural foods are imbued with social meaning, political ideologies, and psychological phenomena. In their book *Sociology on the Menu*, sociologists Alan Beardsworth and Teresa Keil note, "When we eat, we are not merely consuming nutrients, we also [are] consuming gustatory experiences, and, in a very real sense, we are also 'consuming' *meanings* and *symbols* (Beardsworth & Keil, 2009, p. 51). Meat especially adheres to Beardsworth and Keil's ideology, as it is the most avoided, forbidden, and regulated food in the world, which renders it the site of political and social contestation (Willard, 2003). Yet, paradoxically, meat's vast consumption renders it symbolic of something distant from other commonly consumed foods, something that embodies a form of status and historical substance. This is especially true in America, where meat-eating is a focal point of the country's identity and culture.

In America, we exist as a burger, a strip of bacon, or a hot dog; these are the foods that hold an underlying meaning of the way in which we live and hold ourselves. Americans celebrate their very independence with beef burgers and hot dog eating contests and give thanks to family and friends with turkeys. Serving beef at your neighborhood cookout is as patriotic as buying a gun (Friend, 2019). Buying a gun to kill and consume an animal has become an American pastime. Former President Trump even declared meat as "essential" under the Defense Production Act to keep meat processors on the job during COVID-19 (Ziegelman, 2019). Meat-processing is as old as the country itself, and its history is weaved into who American culture (Lisa, 2020).

Meat has become a metonymy for America. The red that drips from our steaks and burgers flow gallantly in our stars and stripes; the Western American farmer is emblematic of the nuclear family, the hard-working and hard-earning person, the American Middle Class.

But how did we get here?

Meat, Men, and Popular Culture

Today, most of our planet's animals exist in industrial farms. Earth is inhabited by forty thousand lions and one billion domesticated pigs; five hundred thousand elephants and 1.5 billion domesticated cows; fifty million penguins and fifty billion chickens (Shapiro & Harari, 2018; Figure 2). Many vertebrae animals roaming Earth are no longer free-living and free-willed but rather are owned and operated by another animal: *Homo Sapiens* (Shapiro & Harari, 2018). Animals are no longer treated as living creatures who can feel emotion or understand stress but rather as machines for producing goods for human consumption—they are cogs in a production line, a measure of revenue for corporations, a symptom of capitalism.

FIGURE 2. Industrial farming of chicken. Reprinted from The Humane League, 2021.

While industrial farming has furthered societal rhetoric of our innate dominance over animals, the meaning of meat consumption has since shifted towards dominance over other humans—a symbol of masculinity and power (Friend, 2019).

Willard observes that the American historical narrative of meat has been widely associated with masculinity, as if the consumption of animal flesh provides "masculine" physical power and stamina (Willard, 2003). Jeremy Rifkin, author of *Beyond Beef: The Rise and Fall of the Cattle Culture*, believes that "the identification of raw meat with power, male dominance, and privilege is among the oldest and most archaic cultural symbols visible in contemporary civilization" (p. 244). Rifkin's statement aligns with the belief from Emily Contois, author of *Diners, Dudes & Diets: How Gender & Power Collide in Food Media & Culture*, who contends that in culture, meat is understood as masculine—that eating meat is how you prove your masculinity—and that, in contrast, salad is aligned with femininity (Contois, 2018).

These symbols reflect ideas from Carol J. Adam's *The Sexual Politics of Meat: A Feminist-Vegetarian Critical Theory*. In her book, Adam explores the idea of "the absent referent," a concept stating that behind every meat-centric meal is the death of the animal whose place the meat takes, and the absent reference function is to hide the violence inherent to carnivory and any cognitive dissonance associated with the guilt of meat-eating—the guilt of acknowledging "something" used to be "someone" (Adams, 2018). Adams further states that animals and women act as

objects in Western patriarchal society; they are located lower on a hierarchical ladder than men (Adams, 2018).

The connection of meat and masculinity is reflected in popular culture, as well. A 1940s Campbell's Soup advertisement unveils the development of Beef Soup with a sign that states, "For Men Only," revealing the long-standing origins of the meat-masculinity dynamic in America (Figure 3). This has continued with the rise of fast-food culture. In the 2007 Burger King advertisement, "I am Man", a man exits a fine dining restaurant to eat a Burger King Texas Double Whopper exclaiming, "I'm a man, hear me roar…I'm too hungry to settle for chick food" (feetah, 2007). Moreover, Former President Trump served a variety of fast-food burgers to collegiate football champions, calling it "Great American food" (Victor, 2019). Meanwhile, McDonald's, the leading producer of the "Great American food" produces more emissions than Norway (Elgin, 2021).

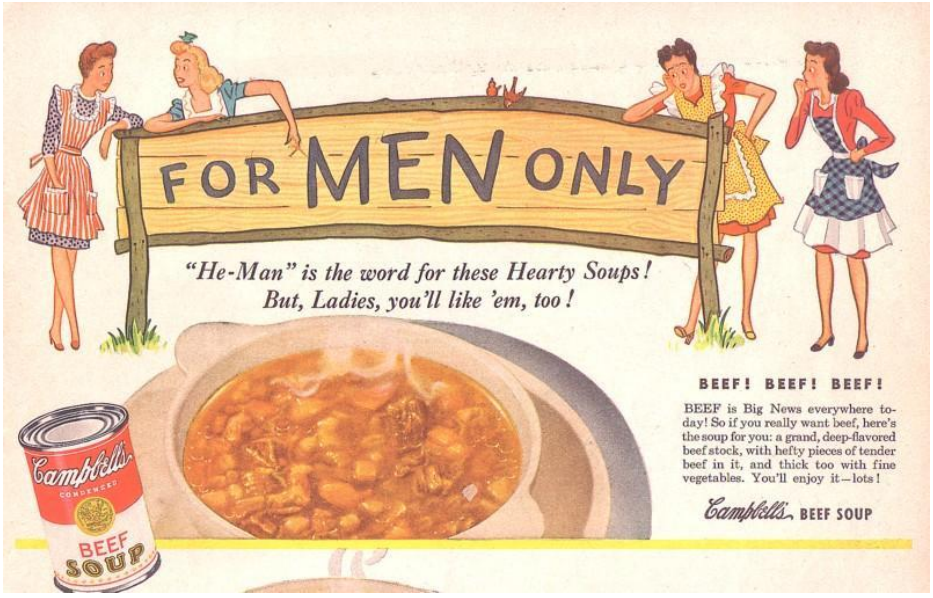

FIGURE 3. 1940's Campbell's Soup Advertisement of Beef Soup: Reprinted from The Society Pages, 2009.

American identity and meat have evolved to be synonymous; consumption of the product is tethered to our very *historical* ideals and values—patriotism, patriarchy, and the following of God's word. Meat is not merely just a food in American culture, but rather is a symbol of what its people believe and an embodiment of their principles.

The American infatuation with meat has caused consumption to rise to 274 pounds per person per year on average, a 40% increase since 1961 (Christen, 2021). This massive increase in demand has been a major driver of the spread of pathogens, as well as a cause of deforestation, biodiversity loss, and methane emissions (Espinosa et al., 2020).

But the widespread relationship with conventional meat may have reached its crux; with an urgent need to change behavior to mitigate the

effects of climate change coupled with humans' tendency to transition to more efficient technology-enabled solutions over conventional ones, meat—and all it encompasses—may be redefined and reconceived to an updated version: cultured meat.

However, the replacement of conventional meat by cultured meat will not be a matter of a simple transition in the diet; the process requires breakthroughs in science and technology as well as structural and cultural shifts in consumer behavior.

Cultured Meat: A Multidisciplinary, Multicultural Innovation

One of the most pressing challenges the cultured meat industry faces is deploying its technology at scale to feed billions of people across the world. Stephens et al. (2018) furthers this idea, noting, "The most ambitious production target - producing cultured meat on a scale that could make marked impacts on global climate change - is likely to take many decades, if it is at all possible." Several studies pinpoint the specific reasoning for Stephens' argument, outlining the current gaps in science and infrastructure that may cause this potentially revolutionary concept to remain a *concept* rather than a *product*.

Technological Considerations for Global Production

On the technical side, Chriki and Hocquette (2020) recognize start-ups are still incredibly far away from producing filet-like muscle with organized fibers, blood vessels, nerves, connective tissues, and fat cells; they note most companies are working with stem cells or muscle cells to reproduce unorganized muscle fibers, resulting in a product like ground beef or chicken nuggets (Chriki and Hocquette, 2020). Stephens et al. (2018) adds that the challenge of producing a cultured filet is to use tissue engineering to replicate the muscle-growing environment found in animals and recapitulate it in a bioreactor and to do this on a scale that is far greater and far cheaper than current use-cases observed in the medical industry.

Acclaimed food-technology journalist Joe Fassler of *The Counter*, a nonpartisan newsroom investigating issues surrounding food, explains the biotechnological feat that must occur for cultured meat to be produced at scale. Fassler (2021) observes that the entire biopharmaceutical industry boasts around 6,300 cubic meters in bioreactor volume (1 cubic meter is equal to 1,000 liters), and a single hypothetical cultured meat facility producing 10,000 metric tons of cultured meat per year would require nearly a third of that volume—only to make a sliver of America's meat. And, if the cultured meat industry wants to capture just 10% of the world's meat market by 2030, it would need 4,000 factories like the one modeled (Fassler, 2021). Additionally, Che Connon, tissue engineer at Newcastle University, estimates that to feed the world's population using cultured meat would require building systems for growing on the order of 10^{24} cells annually, a feat that Connon believes is not possible with the techniques currently used in mammalian-cell-based manufacturing (Dolgin, 2020).

Fassler and Connon's point illustrates the technological feat that must occur for cultured meat to scale and transform from a mere taste-test product to an integral foodway.

Moreover, improvements in cell source material and cell culture medium are needed (Dolgin, 2020). One of the most critical driving costs for cultured meat is cell culture medium (a growth medium designed to support the growth of cells), which is estimated to account for up to 95% of the product's marginal costs (Specht, 2020). But total costs of medium are coming down as start-ups devise breakthrough ways to manufacture these products. An analysis from The Good Food Institute, a nonprofit working to accelerate alternative protein innovation, modeled that by 2030, the cell culture medium raw material cost of cultured meat could drop to $5.49 per kilogram ($2.49 per pound) (Specht, 2020). This scenario would render the production process economically viable for many commodity meat products, as the production costs for products like ground beef, boneless chicken breast, and ham hover around $1.50 to $2.00 (Specht, 2020).

Chriki and Hocquette (2020) also remind us that the industry has come remarkably far since its inception, providing a case study of Professor Mark Post from Maastricht University, who made the first cultured hamburger in 2013 (Figure 4). At the time of production, that burger cost $300,000; today, that same burger—through Post's startup Mosa Meat—would cost $9, a 33,000-time decrease in just eight years (Chriki & Hocquette, 2020). Further, at the time Israeli-based cultured meat company Future Meat Technologies was founded in 2018, the cost to create a cultured beef hamburger hovered around $8,000/kg; In 2022—just four years later—Future Meat Technologies has brought production cost down to $1.70/kg (Specht, 2020; Future Meat Technologies, 2022). Cost decreases of this magnitude point to a sign of drastic innovation for the nascent industry, attenuating Fassler's arguments.

Just as electric vehicles and clean energy—which previously were not economical—have gradually replaced gasoline-powered cars and fossil fuels, cultured meat could follow in stride, gradually replacing conventional meat. At first, cultured meat will be a luxury product rather than a commodity, but with continued research and development and scale, its price will fall and steadily replace its previous version (Peppou, 2021).

Further, consulting firm Kearney suggests that 35% of all meat consumed globally will be cultured by 2040 (Ewing-Chow, 2021). Thus, what began as a sci-fi fantasy in 2013 will become a global industry and global movement in just thirty years, illustrating the monumental breakthroughs the cultured meat industry has exhibited (and will continue to exhibit) since its creation.

While scholars and scientists may disagree on the biotechnological feat ahead (and its feasibility), what is understood across the field is the

urgency of decisiveness and clarity in this product's nomenclature, for the very rhetoric may influence whether demand for a new meat exists.

FIGURE 4. The First Cultured Meat Burger developed by Professor Mark Post in 2009 (raw (left), cooked (right)). Reprinted from Popular Science, 2013.

The Politics of Cultured Meat

Chriki and Hocquette (2020) indicate that *in vitro* meat stands at the intersection of meat and non-meat. It is this intersection that makes the policy angle of cultured meat so crucial and so complex, for the very definition of 'meat' may ultimately play a role in shaping the rhetoric of alternative versions of the conventional product. Indeed, the formal dictation of what this novel product *is*—and equally important what it is not—may prove to be an indicator of the future success of this market. Bryant and Barnett (2019) speak to this notion, adding that cultured meat may fall outside the US's Federal Meat Inspection Act's definition of meat, which defines meat as coming from an animal carcass. Chiriki and Hocquette (2020) include a relevant example, as well, pointing to a new law in Missouri that states for a product to be called "meat", it needs to come from a real animal as defined by most dictionaries. Thus, as it stands, in America, cultured meat may not be able to be labeled as "meat" if formal definitions are not revised (Bryant, 2020).

Other nations—particularly Singapore and Israel—are taking more lenient, progressive approaches to regulating cultured meat. In fact, in December 2020, Singapore announced the first approval for the commercialization of a cultured meat product (Treich, 2021). Treich (2021) does not see this as a surprise, as he contends that countries with little or no agricultural land may be more inclined to regulate cultured meat for food self-sufficiency purposes. But Israel, which boasts a massive agricultural industry, is still a leader in cultured meat production, and the government supports its rise in popularity. Recently, former Prime Minister Benjamin Netanyahu directed a state secretary to serve stakeholders operating in the alternative protein field and commented that Israel would become a global leader in alternative meat production (Starostinetskaya, 2021).

Whereas Chiriki and Hocquette (2020) and Bryant and Barnett (2019) only consider possible regulatory pathways (and their likelihood), Treich

(2021) denotes a more nuanced idea: there is a fine line between allowing a potentially toxic product on the market with negative consequences and being too cautious and delaying beneficial innovations and impact. Regardless of a country's regulatory pathway for cultured meat approval, many researchers acknowledge the urgency of decisiveness and clarity on this product's official nomenclature across cultures, for this will instigate and illustrate if a demand for an updated meat product exists.

Evaluating Consumer Acceptance of Cultured Meat

The storytelling of food enables it to be passed on from person to person and from culture to culture; how we talk about food reflects our very decision to consume it. The rhetoric of food is critical to whether we gauge something as good or as bad—as appealing or as disgusting. Chriki and Hocquette (2020) state:

> It is widely acknowledged that the name given to an object or phenomenon can affect subsequent evaluations and impressions of it. Indeed, '*in vitro* meat,' 'clean meat,' 'cultured meat,' 'lab-grown meat,', 'synthetic meat' and other names suggest that this innovation is slaughter-free, more responsible towards our environment and a credible alternative to the current intensive farming systems. (Chriki & Hocquette, 2020, p. 6)

Whereas Chriki and Hocquette (2020) believe 'lab meat' and 'synthetic meat' promote a positive connotation, Stephens et al. (2018) interestingly view these terms as derogatory. Indeed, the contestation over what is perceived as marketable, edible, or true versus what is deemed as unappetizing reflects both the ambiguity over what this product actually is, and the political sensitivities of how different people hope it to be positioned.

A study conducted by Bryant and Barnett on how the name of cultured meat affects consumer perception furthers this point. The two observed that the name 'lab grown meat' and 'synthetic meat' evoked the most negative associations in consumers while the name 'animal free meat' appeared to confuse them (Bryant & Barnett, 2019). Moreover, the name 'cultured meat' evoked an association with science and a deviation from nature while 'clean meat' most commonly evoked associations with health and nutrition (Bryant & Barnett, 2019). Despite discrepancies on what wordage is most appealing, Chriki and Hocquette (2020), Stephens et al. (2018), and Bryant and Barnett (2019) agree consumer perception of cultured meat is dependent upon its very name, for this will affect the light in which we see the product—whether we flinch at tasting it or savor its extraordinariness.

Beyond just its nomenclature, cultured meat acceptance varies by country and by culture. Stubbs et al. (2018) conclude tradition, culture, gender, identity, social values, and socioeconomic status appear to influence trends in meat consumption as well as how we perceive the food itself. Bryant et al. take a holistic country approach to cultured meat's appeal, comparing consumer behavior from America, China, and India.

They concluded that "the most consequential finding of [his] study [was] the significantly higher likelihood of urban, well-educated and high-income consumers in India and China purchasing clean meat and plant-based meat compared to consumers in the USA" due to differences in health, government, and ethical perspectives (Bryant et al., 2019, p. 7). The result of this study appears to be an indicator of that nation's very relationship with meat. Americans, being attached to traditional meat, are less inclined to try an alternative; in fact, 23.6% of Americans surveyed said they were not at all likely to purchase clean meat, a number far higher than the 6.7% in China and 10.7% in India (Bryant et al., 2019).

Both Stubbs et al. and Bryant et al. recognize the role that culture—an underlying building block of who we are—plays in how we perceive food; that culture is a subconscious force behind our dietary decisions, particularly when deciding to consume an item that is unrecognizable from both an ambiguity perspective as well as an evolutionary and anthropological one.

A collective culture's relationship with meat has drastic and differing implications on the pure willingness to change meat consumption. That said, as the economics of cultured meat become feasible to a global population due to more frequent scientific breakthroughs and conventional meat becomes more of a luxury product due to climate-induced stress on production (Quinn, 2021), it is only a matter of time until technology causes a shift in our culture once again. This technological disruption will occur in something that is rooted in human evolution and psychology and will have massive implications on our relationship with nature, with food, and with the use of technology.

A Pivotal Innovation in Our History

While foodways are inherently structured and rooted in culture, significant historical movements and discoveries have shown an ability to recreate them. Theism—and the collective belief in higher power of God—caused humans' diet to transition from scarce meat-eating with a vegetable-forth prominence to one of industrial farming and animal slaughter for the sake of human appetite. Technology—and the collective belief in the higher power of innovation—may cause humankind's most prominent foodway, meat, to shift once again. I argue this shift will be noted by a gradual transition away from slaughterhouse meat to technology-based meat.

Restructuring Our Relationship with Conventional Meat

While the phase-in of cultured meat and the phase-out of our current relationship with meat may be subtle, timely, and seemingly difficult, shifts in our foodways—just as shifts in our histories—can and have occurred. Cultures, and thus foods, have molded and changed with time. Perhaps it is best to think of the meat to cultured meat restructuring as a process of permanence and change driven by *orientations*, using concepts from literary theorist Kenneth Burke (Willard, 2003). According to Burke

(2020, p. 14), we can think of orientations as a "bundle of judgements as to how things were, how they are, and how they may be". Willard (2003) recognizes these orientations act as guides for human action; they are the force that allows for permanence in a culture, but they can also be altered over time, and consequently gradual changes in practice occur.

Relating to meat, orientations inform us of our historical precedent of human dominance over animals, slaughter, and mass consumption; however, as Willard proposes, this precedent can change over time—perhaps to new modes of meat consumption or new foodways altogether. This certainly applies to cultured meat. Willard adds an excerpt from William Rueckert, author of *Kenneth Burke and the Drama of Human Relations*, to further justify this belief:

> In the course of history, which is marked by necessary and inevitable change, one major orientation is established, rigidified, and formulated only to collapse when it no longer satisfies the needs of a given period or is discredited by new knowledge. After a chaotic transitional period, a new orientation is gradually established, rigidified, and systematized. (Willard, 2003)

Our consumption of slaughtered meat is a prime example of Rueckert's claim. While our current relationship with meat—and the American meat identity—has been thoroughly established and rigidified for the past centuries and does satisfy the conceived *needs* of people, it does so at an extremely high cost. With the introduction of the more efficient, soon-to-be more economical alternative that is cultured meat, antiquated industrial meat production methods will be "discredited" by an innovative technology. This technology will enable governments to redistribute water to its people and other resources, convert otherwise-agricultural land to land for the ten billion people that will soon habit our world, and provide protein for those who are currently food insecure. Thus, a new orientation—the consumption of cultured meat—will be "gradually established, rigidified, and systematized" throughout society (Rueckert, 1982, p. 37).

In contrast, *fixation*, which presents a challenge in the 'openness to experience,' may inhibit the ability to innovate our food production and consumption processes (Kumar & Bharadwaj, 2016). According to Kumar and Bharadwaj, fixations are "emotional, cognitive, social rigidities, narrowness within us that blurs information and depletes our ability to innovate" (p. 9). In the transition to cultured meat, fixation on current production and consumption methods of meat may occur. Because what we eat is an emotional, cognitive, and social experience, the restructuring of our conception of meat (and subsequent consumption) may induce hesitation and lack of willingness to 'innovate' in individual and collective behavior.

However, what often trumps fixation is empathy. Empathy is the ability to stand for the needs of others, and innovation is often a result of empathy—"a process of decentralizing or deconstructing an idea or

process in the minds of other people" (Kumar & Bharadwaj, 2016, p. 10). In relation to meat, humans' increasing empathy towards problems associated with climate change may overcome our current fixation of slaughtered meat. Those who possess this empathy will be the early adopters of cultured meat—the "innovators", according to Rogers' Adoption curve (Figure 5) (Swan, 2020). These "innovators" will provide the necessary exposure of cultured meat to a greater percentage of the population, perpetuating the product's adopters and its consumption.

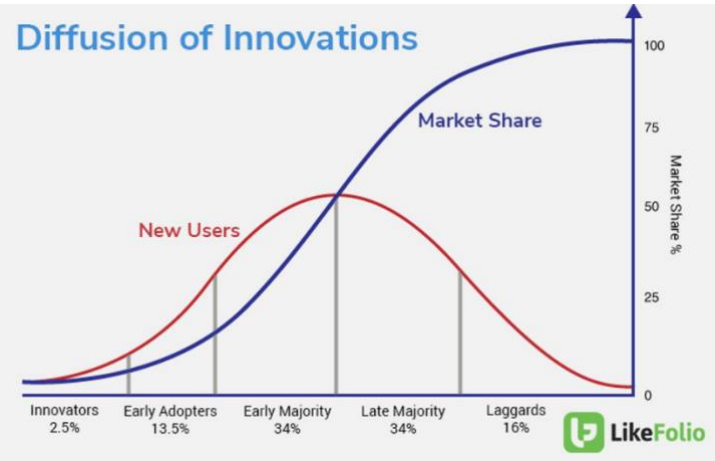

FIGURE 5. Graph of Roger's Adoption Curve. Cultured meat consumption will be driven by the "innovators". Reprinted from Forbes, 2020.

Moreover, analyzing our relationship and consumption of meat from an anthropological, sociological, and historical lens enables us to create our future relationship and consumption of it. In his book *Homo Deus*, historian Yuval Noah Harari comments that we study history to notice possibilities that our ancestors could not imagine; that "by observing the accidental chain of events that led us here, we realize how our very thoughts and dreams took shape—and we can begin to think and dream differently" (Harari, 2018, p. 60). And so, by identifying the chain of event—from the Bible to present day Industrial Farming—that has led humans to their obsession with meat, we can begin to dream and create a new future of its production and consumption.

Harari continues, "Movements seeking to change the world often begin rewriting history, thereby enabling people to reimagine the future…If we act wisely, we can change that world, and create a much better one" (Harari, 2018, p. 60). If we act wisely, we can begin to utilize the technologies at our disposal as a means for social good. Cultured meat may rewrite our meat-eating history and enable humankind to reimagine the future of food, sparking movements that associate diets with activism and action—reflections of who we are and what we value, insights on the progress of sapiens.

Now, how do we get there?

Our Historical Innovation of Food

Human psychology inherently pushes people to innovate—to find novel solutions that enable them to adapt and survive in their environment, oftentimes for purposes of efficiency. This certainly applies to food, as sapiens have historically utilized the most innovative technologies at their disposal to structure and formulate their diet.

Dating back between 300,000 and 400,000 years ago, the habitual use of fire for the act of cooking enabled our early ancestors to bring people together to share in the act of eating, laying the foundation for pair bonding and human society (Adler, 2013). Consequently, we began to think abstractly, communicate complex thoughts, and culturally accumulate information over generations (Bostrom, 2014). And dating back 7,000 years ago, The First Agricultural Revolution enabled sapiens' population densities and total number of people to rise, which meant more ideas and the ability for those ideas to disseminate more readily, leading to more economic productivity, technological capacity, and the development of specialized skills (Bostrom, 2014). These advancements induced the rate of growth of economic productivity and technological ability to increase (Bostrom, 2014).

In the nineteenth century, steam power and the refrigerated railcar perpetuated the shipment of slaughtered cattle across states, rendering meatpacking America's biggest industry at the time (Lisa, 2020). And while inhumane and unsanitary, modern science enabled humans to develop vaccinations, medications, hormones, pesticides, and automatic feeders to cram thousands of chickens into tiny coops and produce meat at an unprecedented pace, allowing us to feed a growing population (Shapiro & Harari, 2018).

Today, biotechnology can be used to fundamentally redesign meat. The development of this technology has enabled humankind to produce a food that can feed our growing population in an ethical, sustainable, and economic manner. And once the price of clean meat reaches price parity with conventional meat, it will make not only ethical sense but also economic and ecological sense to replace slaughterhouses with 'biofarms'; consumers will purchase the cheaper product, and cultured meat will begin to orient itself into society (Shapiro & Harari, 2018). Consequently, our historical relationship with meat—our very conception of what it is and what the product stands for—will begin to deviate from its norm. Eating meat will no longer represent human dominance over animals, masculinity and power, and environmental destruction, but rather will symbolize animal equality, innovation for the sake of societal good, and the evolving importance of climate change and health in the minds of people.

A Healthier, "Profiled" Meat Alternative

The integration of cultured meat as a foodway can have potential personal health benefits compared to conventional meat—which is known to lead to higher risk of obesity, cardiovascular dieases, type 2 diabetes, and some

forms of cancer (Boada et al., 2016). These benefits are two-fold: (1) in the product itself and (2) through a de-risking of harmful effects associated with raising livestock.

Regarding the former, a future possibility exists for cultured meat to be "profiled" to adjust for healthier content including type of fat (e.g. substituting omega-3 fatty acids for saturated fats), vitamin content, proteins, amino acid composition, and minerals (Gabbert & Tarhuni, 2021; Treich, 2021).

Regarding the latter, industrial farming typically consists of antibiotic treatment and hormone injection in animals to prevent animal illness and encourage muscle growth, respectively (Gabbert & Tarhuni, 2021). These treatments can affect human health and lead to antibiotic resistance as well as the transmission of animal hormones to humans, which can have developmental, neurobiological, and carcinogenic effects (Gabbert & Tarhuni, 2021; Watson, 1999). Because cultured meat is produced in a sterile environment, there is no need for antibiotics and thus the potential for meat-induced damages to health may be drastically reduced (Gabbert & Tarhuni, 2021). As consumer trends continue to push for healthier alternatives to conventional options, the possibility of a "better-for-you" meat will appeal to meat-eaters and vegetarians alike. Cultured meat as the "healthy" option may push the demand for and adoption of this market forward.

Food as a Matter of National Security

Food security is a matter of national security. Food shortages have been the root cause of many national and international security issues; if a state cannot provide the most basic needs of food and water to its people—if crops fail and prices rise—the people will likely steal, revolt, protest, and cause various forms of social unrest (Frankelius, 2019). According to Zhang et al., based on a quantitative analysis of war-peace cycles occurring throughout human history, relative food scarcity has been a fundamental cause of war outbreaks, manifesting itself in two ways: a direct cause, in which resource-oriented wars sparked due to an inability to satisfy lower levels of Maslow's Hierarchy of Needs, and indirectly, as "constrained food resources and economic difficulties stemming from that intensified different social contradictions, that increased the likelihood of war outbreaks" (2007, p. 5).

For example, bread shortages in France in the late 1700s helped ignite the French Revolution (Packham, 2014); during the global food crisis in 2007-2008, food shortages (reflected in rising prices) in staple goods caused violent popular actions, especially in developing nations (Bello and Baviera, 2009); Terror group ISIS leveraged drought and crop failures to win the support of vulnerable peoples and spread its reach (Spence, 2021); and currently in the past decade, we are beginning to experience global food shortages/food insecurity and higher prices due to climate change (i.e. increasing temperatures, changing precipitation patterns, and greater

frequency of extreme events (Gregory et al., 2005; Mbow et al., 2019). As climate change persists and worsens, crops will fail, prices of staple foods will rise, and social unrest may occur.

Thus, the need for adaptation and a redistribution of resources is imminent to prevent future food shortages and national/international conflict. Cultured meat can provide critical resource redistribution—particularly among water and land—that appears to be critical to battling the drastic impacts climate change poses on food security. According to Matthew Spence, former Deputy Assistant Secretary of Defense for Middle East Policy and Senior Advisor to the National Security Advisor during the Obama Administration, accelerating the investment in and development of the alternative protein industry is a politically feasible and technologically possible step to advance national security and general long-term security risks (2021). Spence's comment illustrates that the investment in and production of cultured meat may have impacts that span across borders and across the defining issues of today: eliminating climate change, enhancing human health, and preserving national and international security.

Conclusion: Food, Technology, and Our Future

History has continuously illustrated major innovations in food-related technologies have led to greater, more paramount shifts in the development of human beings. With the creation of cultured meat, we have reached another pivotal innovation—and thus pivotal turning point—in the evolution of humanity. Not only will cultured meat shift our very conception of meat from its previous form and previous symbolism, but it will have influence on the growth of humankind—population wise, economically, ecologically, and technologically.

The power of biotechnology—the building block of cultured meat—should be noted, as well. On one hand, we could use it to design cows, pigs, and chickens to grow faster and produce more meat, perpetuating the current cycle of industrial meat production and environmental destruction. On the other hand, we could use this novel technology to create a meat that will transform animal agriculture, provide farm animals their salvation, and perhaps forge movements in humanity that cannot yet be predicted (Shapiro & Harari, 2018). As Shapiro and Harari (2018, p. 5) state, "The transformative nature of this technology is hard to overstate. In the not-too-distant future, we may look back at industrial animal farming…[as]…a dark a chapter in the history of humankind".

As humans evolve, we have developed technologies that are more powerful and more influential on our species than their predecessors—for better and for worse, for abilities of creation and destruction. Artificial intelligence, nanotechnology, and biotechnology will prove pivotal to our ascension or destruction. These technologies can strengthen authoritarian regimes, lead to racial biases, and even transcend us to a new, god-like species—*Homo Deus.*

But humans have the power to decide what to do with such technologies; we can utilize them uncontrollably and without profound thought, or we can use them to make our planet a more equitable place in which to live. Cultured meat is a crucial example of this.

When my family sits around the dinner table in 2050, I hope we continue to love, to share, to laugh, and to be present with one another—to embrace the power of food. And I hope humanity's use of biotechnology will have been used to better our planet, to create a novel foodway, a new staple, and a new belief in what meat is and can be. But until cultured meat is widely available and accessible, I will take measures to reduce my dietary environmental footprint: having meatless days every week, purchasing meat from trusted, local producers, consuming less beef, and making meat eating something special—something communal and to be shared and enjoyed with friends and family. I hope those who read this will do the same.

FIGURE 6. The Evolution of Meat and Meat Production. Reprinted from Nature, 2016; History, 2019; Stravaganza, 2016; Plains Humanities, 1992; The Guardian, 2018; Food Processing Technology, 2020.

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