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Vegetarian Meat: Could Technology Save Animals and Satisfy Meat Eaters?

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Abstract Between people who unabashedly support eating meat and those who adopt moral vegetarianism, lie a number of people who are uncomfortably carnivorous and vaguely wish they could be vegetarians. Opposing animal suffering in principle, they can ignore it in practice, relying on the visual disconnect between supermarket meat and slaughterhouse practices not to trigger their moral emotions. But what if we could have the best of both worlds in reality—eat meat and not harm animals? The nascent biotechnology of tissue culture, originally researched for medical applications, holds out just such a promise. Meat could be grown in vitro without killing animals. In fact, this technology may not just be an intriguing option, but might be our moral obligation to develop.

Keywords Animal suffering · Animal welfare · Artificial meat · Biotechnology · Carniculture · Cultured meat · Food production · In vitro meat · Moral vegetarianism · Tissue culture

The Problem of Eating Meat and Caring for Animals

Modern American society loves to watch television cooking shows—the creativity, the sensuousness, the clever techniques. But chances are, if a lamb were dragged in and killed at the beginning of the program, most of the viewers would find themselves less interested in the lamb chop recipes. They would be too horrified or disgusted to enjoy the rest of the

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program.[1] And yet, if the lamb's flesh is brought in already killed and sliced, almost all sense of horror and sympathy is muted enough to be nearly unfelt.

This is one of the disconnects of modern society. It is a widely commented on oddity that people can spend nearly as much money on their pets as on their children, oppose animal cruelty, and yet casually eat meat from slaughtered animals (Saletan 2006). There is also a widely commented upon explanation for the fact that most people who eat meat in modern societies can do so without triggering enough cognitive dissonance to stop. The way meat is presented to consumers avoids triggering horror or sympathy by being sterile and distancing—it appears in neat and nicely wrapped packages under bright lighting in the supermarket; fresh, clean and detached from its source, sometimes ground or covered in spices, and largely cut in such a way that we cannot even tell by looking which part of the animal the tissue comes from. Except for the tell-tale blood that pools up under the meat which we distastefully discard at home, there is little visual and cognitive connection between the meat before us and the animal from which it came. The oddity of meat-eating animal lovers is therefore easy to understand.

What is not so widely commented upon is the fact that there are people who are uncomfortable carnivores and they know the explanation of this oddity. They do despise animal cruelty; they may belong to some animal welfare and protection organization; they may avoid eating veal in some self-admittedly inconsistent attempt to oppose cruel practices. They know in fact that they rely on the supermarket disconnection between animal and meat in order to continue eating meat, and to greater or lesser degrees and greater or lesser frequencies feel guilty about it all. The problem is that they love eating meat. Given that it is so easy to avoid the horrors of where the meat comes from, and given that vegetarianism seems such a literally and metaphorically unappetizing lifestyle, they can fairly easily put it out of their minds. But they wish vaguely that they could be vegetarians.

For the far greater number of people who eat meat without experiencing guilt, it is not difficult to make them very uncomfortable by talking about the sources of meat and the slaughter practices that provide it. They may not think about it at all unless forced to, but a charming day taking the children to a petting zoo followed by a trip to a fast food

[1] Even members of the curious category of macho chefs remark on the horror of watching how an animal gets turned into food. Anthony Bourdain writes: "I was already unhappy with what I was seeing. I'm causing this to happen, I kept thinking. This pig has been hand-fed for 6 months, fattened up … I was responsible. For a guy who'd spent twenty-eight years serving dead animals and sneering at vegetarians, I was having an unseemly amount of trouble getting with the program. I had to suck it up…It took four strong men, experts at this sort of thing, to restrain the pig, then drag and wrestled him up onto his side…With the weight of two men pinning him down and another holding his hind legs, the main man with the knife, gripping him by the head, leaned over and plunged the knife all the way into the beast's thorax, just above the heart. The pig went wild. The screaming penetrated the fillings in my teeth…With an incredible shower of fresh blood, the pig fought mightily…They finally managed to wrestle the poor beast back up onto the cart again, the guy with the mustache working the blade back and forth like a toilet plunger…" (Bourdain 2001, pp. 21–22). Michael Ruhlman writes of Chef Thomas Keller's experience of killing rabbits: "If he were going to cook rabbits, he should know how to skin, gut and butcher them as well. The purveyor showed up but did not prove to be an elegant teacher. He knocked one rabbit out, slit its throat, pinned it to a board, skinned it, and gutted it, then left. That was it. And Keller was alone in the grass behind the restaurant with eleven cute little bunnies. Bunnies are cute. Soft fur, long ears, little pink noses, warm, yearning eyes. Keller didn't want to kill them. But he had no choice at this point and eventually cranked up his resolve and made for one of the rabbits. 'Rabbits scream,' Keller told us at dinner. 'And this one screamed really loud.' It was an awful experience, he said. He tried to kill it, but the rabbit was screaming so loud and struggling to get away the work was difficult. Then the rabbit's leg snapped as it struggled to get away. So while it was still terrified and no likely in great pain, it could no longer run away, and Keller managed to kill it." (Ruhlman 2001, p. 289)

restaurant and the tiniest bit of intellectual prodding can produce, if not guilt, at least a request to stop talking about it.

The point is that for many, many meat eaters, there is no joy taken in the thought of animal suffering or of animal dying. There is great joy taken in eating meat, however, and since the thought of animal suffering can be so easily divorced from eating animals, the inconsistent practices continue unabated. And yet it is worth noticing that the dominant argument for vegetarianism—the argument that (a) it is wrong to cause unnecessary pain and suffering; (b) eating meat causes unnecessary pain and suffering; (c) so eating meat it wrong—is mostly an argument with which reluctant and even not so reluctant meat eaters would agree (Rachels 2004). It is just that those sterile supermarket practices make the second premise of the argument very, very easy to ignore and so the conclusion is never forced upon the consciousnesses in any demanding way.

For those people who care about animal suffering and who are conscious of how meat-eating practices create such suffering, promoting vegetarianism is typically a matter of trying to educate others (more or less aggressively) or trying to model behavior. But these approaches have their limits[2] and while moral vegetarianism has grown over the years, it still pales in comparison with the culture of eating meat.[3]

The problem then is basically that many people do not want to contribute to animal suffering and yet still very much want to eat meat. They can easily do this with the support of the conceptual and visual disconnect between their meat-eating and animal suffering. Is there any way around this? Beside the obvious answers of more guilt or more education—which would still require meat-eaters to give up something they very much enjoy—is there anything that would help? Ideally, what would work best would be something that allowed people to eat meat without contributing to animal suffering or animal death. More humane practices in slaughtering animals might help somewhat, but this will hardly satisfy those who believe that animals have the right not to be killed in the first place.[4] Better yet would be something that allowed people to eat real meat without killing animals at all. Strange though this may at first seem, there is such a possibility, brought to us by biotechnology.

Biotechnology and Animal-Friendly Meat

First of all it is important to realize that we are not talking here about meat substitutes, or "artificial" meat, or meat-like substances that are conglomerations of soy products and

[2] Rina Deych comments that she has only "converted" a handful of people to vegetarianism and thus has become more pragmatic (Deych).

[3] In a 2003 Vegetarian Resource Group Harris Interactive survey, 2.8 percent of those surveyed said they never eat meat, poultry, or fish/seafood (Vegetarian Resource Group 2003). It is also worth noting that it is questionable whether even strict vegetarianism would produce less suffering for animals overall. If vegetarianism increased the amount of land used for food production, then many animals might be killed or displaced to create such farmland. It might be the case that producing a pound of tofu produces more animal suffering than producing a pound of cheese.

[4] In this paper, we are focusing primarily on the suffering that current meat production practices create. However, we acknowledge that there are ways to keep and slaughter animals that cause far less suffering than those which we now employ in industrial practices. In spite of the possibility of more humane alternatives, though, the ideal solution would be to eliminate the need to keep and slaughter animals at all, given the difficulty of ever creating truly "humane" practices when so many market forces pressure the meat production industry to pack more and more animals into less and less space. In this sense, what we are suggesting is not "more extreme" than more humane slaughter practices, but is a way to avoid the numerous problems with instituting truly humane practices within the current system.

gelatins—not even meat substitutes that taste and have textures exactly like real meat. We are talking about the possibility of real, genuine meat—genuine animal muscle tissue—that is animal-friendly in the sense that it requires no animal suffering and no animal death to produce. Such a solution, at least at first glance, would seem to provide everyone with what they want. Meat-eaters have real meat; those who oppose animal suffering reduce animal suffering; those who promote animals' rights to life keep animals alive; and most importantly, the animals themselves are no longer subjected to painful and life shortening food production practices.

So what we are talking about here is biotechnologically produced meat. Depending on the method of production it might be called cultured meat, or synthetic meat (though using "synthetic" in terms of being manufactured, not in terms of being inauthentic), all part of the practice of "carniculture" (to parallel producing plant food through agriculture). Imagine in some way a laboratory that could produce meat through a technological process; real steaks, real prime rib, real chicken breasts, real veal, grown in a lab. Though certainly not a practical option right now, there are reasons to think such a thing could be become available. Consider the following possibilities (ranging from those currently in use to the more speculative).

Scaffolding Techniques

Meat is already cultured on small and early scales using a variety of basic procedures, including techniques that use scaffolds and those that rely on self-organization (Edelman et al. 2005). For instance, skeletal muscle cells can be grown on small beads or mesh suspended in growth medium, some of which can even stretch to simulate motion and firm up the resulting meat. Cells fuse to form fibers that can then be harvested. Other forms of scaffolding could also be used, for example, growing muscle tissue on large sheets of edible or easily separable material. The muscle tissue could be processed after being rolled up to suitable thicknesses (Edelman et al. 2005). While these kinds of techniques work for producing ground meats with soft consistency, they do not lend themselves to highly structured meats like steaks. However, cells can also be grown in substrates that allow for the development of "self-organizing constructs" that produce more rigid structures.

Self-Organizing Tissue culture

In 2002, M. A. Benjaminson and colleagues made science news headlines by growing fish muscle tissue in culture (Benjaminson et al. 2002; Britt 2002; Sample 2002; Hukill 2006). Working on ways to make animal muscle protein available for astronauts, Benjaminson and his team took slices of goldfish tissue, minced and centrifuged them to form pellets, placed them in Petri dishes in a nutrient medium and grew them for 7 days. The explanted tissue grew nearly 14% when using fetal bovine serum as the nutrient medium and over 13% when using Maitake mushroom extract. Experiments in which the explanted tissue was bathed with a dissociated crude cell mixture composed of goldfish skeletal muscle tissue grew a surprising 79% in a week's time.

After a week, the explants and their newly grown tissue, which looked like fresh fish filets from a supermarket, were cooked (marinated in olive oil and garlic and deep-fried) and presented to a panel for observation. The panel reported that the fish looked and smelled good enough to eat. They did not actually eat it, given the experimental nature of the food, but reporters were impressed that the fish reacted to cooking as would normal fish

filets and looked appetizing. The researchers are continuing their studies on poultry and beef tissue.

Now of course, this research is hardly complete. Nothing in it by itself would satisfy someone wanting to eat meat without harming animals. Fish were killed. However, the muscle tissue did increase in size and new growth not coming directly from a killed animal was produced. Though the research was directed at ways of producing muscle protein for space flight, Benjaminson is quoted as saying "This could save you having to slaughter animals for food" (Sample 2002). The promise of course, is that given the right medium (mushroom extract was successfully used) and given the right way to obtain initial explants to use as substrate for cell dissociations (perhaps biopsy-like procedures for the initial "donors") this form of tissue culturing could produce a variety of meats suitable for eating.

Organ Printing

One of the general problems with engineering suitable cultured meat is the consistency of the product. Current culturing techniques cannot provide the vascularization or the fat marbling or other elements of workable and suitably-tasting meat that are not simply versions of ground soft meat. A potential solution to such problems comes from research on producing organs for transplantation procedures. Not surprisingly, given the confluence of technologies, some of the same people who are working on culturing meat are also working on research in "organ printing" (Mironov et al. 2003).

Organ printing is a simple yet astounding idea. Using the principles of ordinary printing technology—the kind of technology that inkjet printers use to produce documents like this one—researchers have essentially been able to use solutions containing single cells or balls of cells rather than ink and spray these cell mixtures onto gels that act as printing paper. The "paper" can actually be removed through a simple heating technique or could potentially be automatically degradable. What happens is essentially that live cells are sprayed in layers to create any shape or structure desired. After spraying these three-dimensional structures, the cells fuse into larger structures, such as rings and tubes or sheets. As a result, researchers argue that the feasibility of producing entire organs through printing has been proved. The organs would have not only the basic cellular structure of the organ but would also include, built layer-by-layer, appropriate vascularization providing a blood supply to the entire product. For applications focused on producing meat, fat marbling could be added as well, providing taste and structure. Essentially, sheets and tubes of appropriate cellular components could create any sort of organ or tissue you would like—whether for transplantation or for consumption (Mironov 2003, p. 158; Aldhous 2006).

Biophotonics

Biophotonics refers in general to the process of using light to bind together particles of matter. A new field, and one in which the mechanisms are still poorly understood, biophotonics relies on the effects of lasers to move particles of matter into certain organizational structures, such as three-dimensional chessboard, or hexagonal arrays. A surprising property of interacting light, this phenomenon produces so called "optical matter" in which the crystalline form of materials (such as polystyrene beads) can be held together by nets of infrared light that will fall apart when the light is removed. This is a phenomenon a step-up from "optical tweezers" that have been used for years to rotate or otherwise move tiny particles in laboratories. This has a binding effect among a group of

particles that can lead them not only to be moved one by one to specific locations but that can coax them to form structures. Although primarily sparking interest in medical technologies such as separating cells, or delivering medicine or other microencapsulized substances to individual cells, there is an intriguing possibility that such a technology could be used for the production of tissues, including meat. A main researcher in biophotonics, Kishan Dholakia, reports in an interview that he and colleagues are already using the technology to create arrays of red blood cells and hamster ovaries (Mullins 2006). Given the success of creating two-dimensional arrays, there is the possibility of producing tissue formations that use only light to hold the cells together, thus eliminating the need for scaffoldings such as those mentioned above in other techniques.[5]

Nanotechnology

The optical tweezer ability to move individual particles around has intrigued nanotechnologists, who have wildly inventive plans for what to do with the molecular scale sized robots they would like to create (but so far, having few tools with which to make them). Nanotechnology (the production and alteration of materials at the level of the atom and molecule) holds out enormous possibilities and although so far relatively little has been accomplished, tons of money is being poured into the research, suggesting as nothing else that it is taken seriously (http://www.nano.gov). The holy grail of nanotechnology is some version of an "assembler", a robot the size of a molecule that would allow moving matter at the atomic and molecular level. The obvious power of such a technology—given that everything is made of the same basic atoms but simply arranged in different ways—is that we would be able to construct virtually any substance we wanted from scratch by putting together exactly the molecules we wanted. Interestingly, one of the first examples given of the speculative technology of nanotechnology was that of synthesized meat. As Ed Regis writes of nanotechnology guru and pioneer Eric Drexler:

> You could turn dirt into steak if you wanted to. That was an idea Drexler came up with in his college days…He thought that once you had the ability to deal with atoms on an individual basis, you could invent this…meat machine…that would physically transform common materials into fresh beef…You'd open the door, shovel in a quantity of grass clippings or tree leaves…or whatever, and the you'd close the door, fiddle with the controls, and sit back to await the results. Two hours later, out rolled a wad of fresh beef. Well, it sounded incredible. But when you thought about it so did the fact that cattle made beef. What materials did they have to work with, after all, but grass, air, water, and sunlight. Not one of these things looked remotely like steak…Nevertheless, what were cows but walking meat machines? (Regis 1995, pp. 6–7).

In short then, technologies ranging from the actual to the speculative promise a variety of ways to create real meat without killing animals. On top of this, add the promise that genetic engineering could produce cells that have a variety of new qualities that would make meat even healthier and tastier—higher protein, lower fat, high omega 3 acid levels or other healthful concoctions (Kolata 2006). Though still commercially infeasible at the moment or in some cases technologically infeasible for several years to come, the point here is not to be distracted by the fact that we cannot yet make use of these technologies but rather to decide whether we should support the development of these technologies. Some of the researchers in this field, for instance, are so committed to the development of cultured meat—largely out

[5] Also see OE Magazine (2005), and Photonics.com (2006).

of a desire to reduce the suffering of animals—that they have formed companies and organizations to pursue the technology. For example, New Harvest is a "non-profit research organization working to develop new meat substitutes, including cultured meat—meat produced in vitro, in a cell culture, rather than from an animal" (New Harvest 2008).

The question then is how to react to the possibility of cultured meat and in so doing, how to act in such a way as to slow it down or speed it up. After all, while we began with the interesting fact that many meat-eaters are in some ways bothered by their consciences because of the suffering and death of animals, the moral question here is not centrally about the best way to soothe the conscience. The central question is about the best way to reduce animal suffering and whether cultured meat would lend itself toward that end. Is cultured meat a good thing? Will it have morally and practically beneficial consequences? Is it something that should be embraced or something that should be rejected? It is these questions that this paper seeks to address.

In Support of Cultured Meat

The arguments in support of promoting cultured or synthesized meat are very clear and straightforward and are in essence the hopeful outlook of a technological fix. Technology can allow us to change the physical constraints of the world so that we can better avoid the bad and pursue the good. What is bad about meat consumption? Animals suffer and die. The environment is harmed. Humans consume often unhealthful substances.

What could the widespread availability of in vitro meat accomplish? It could eliminate much of animal suffering. It could eliminate much of the environmental damage produced by meat animal farming. It could produce much healthier forms of food for humans and other animals to consume. In addition, it would allow humans the pleasure of eating meat—something we have evolved to enjoy even if we can live without it. Not surprisingly then, cultured meat has found quite a number of supporters, including well-known animal welfare activists and animal rights activists.[6]

The real heart of the issue then will be in the potential objections to in vitro meat. It is there that the rest of this paper will focus.

Objections to Cultured Meat

Inevitably, when going through a series of objections, one will cover material that some think is hardly relevant and others think is the crucial matter, that some think is barely worth mentioning and others think is the highest priority. In what follows we roughly position what we see as the most important and most morally complex objections to cultured meat toward the end, but realize that readers may have different priorities. The order of objections should not then be taken too seriously.

Danger

A common response to any sort of biotechnology is a worry about the danger of consuming untested (or even tested) novel materials. This is of course a very important issue but let us

[6] Hukill (2006) reports that Bruce Friedrich, vice president of PETA calls cultured meat "the best thing since sliced bread." Deych reports a number of well known animal protectionists have "given it the thumbs up," including Peter Singer.

note a few things about it. It is not per se a moral issue but a practical one. It says nothing about what the true success of the biotechnology would mean but only about what the partial failure of the biotechnology would mean. It is clear that eating dangerous materials would be a bad thing. It is also clear that figuring out exactly how to test such materials can be difficult. If however, we assume that at some point the technology can produce meat that is indistinguishable from the kinds of meat we now consider acceptably safe to eat, and thus we have no reason to think it is more dangerous than current meat eating, we are still left with the question of whether there are any other considerations to bring to bear on the issue. To stipulate then, for anything to serve as a potential technological fix, the technology must actually work. If this practical problem can be overcome, then we need to ask what further moral concerns are relevant.

Cannibalism

A curious consequence of the ability to culture meat may seem bizarre but is acknowledged in the discussion of the technology—the ability to culture human muscle tissue, thus leading to victimless cannibalism (Peterson 2006; FuturePundit 2003; McIlroy 2006). One is at pains to know how seriously to take this issue and how much time to spend on it. On the one hand, it triggers the yuck response like nothing else and triggers fears about health problems and slippery slopes to twisted fetishes. On the other hand, it is likely that few people would be interested in eating human meat and even if they were, it is not clear how much of a moral problem such a victimless eccentricity would be. For our purposes here then, we will acknowledge that this is a problem worth talking about, but will largely leave the problems of victimless cannibalism for another discussion.

Reality of Meat

Some people will have a reaction much the opposite of vegetarians. As carnivores, they may feel that the kind of meat we are talking about isn't "real." That is, they will think of it as artificial meat, or synthetic meat and not the real thing. As such, they depreciate the value of the meat in the same way they would look down on artificial flowers or synthetic diamonds. This would simply be a conceptual mistake, however. What makes meat "real" is its constituent substance, not its mode of production. On every physical level, successfully cultured meat would be real meat—real muscle tissue, real protein, real flesh. This is not like an artificial flower that is made of plastic or silk, but a case of real meat that is produced in a medium other than a living animal. It is as real as it can be.

Naturalness

The claim that something should be morally suspect because it is unnatural often arises in these sorts of debates. For some, the quality of being unnatural is the primary objection to cultured meat; for some, it is the weakest objection to cultured meat (and other technologies). The typical complications of claims about naturalness are well known. Nature does not equate with the good. Nature is difficult to define. Nature may be inferior to another state. Nature includes human intelligent manipulation. It would be impossible to thoroughly discuss all the parsings and implications of the concept of naturalness in this paper, but as a general indication, let us consider the following.

Just because something is natural, does not mean it is good for you—arsenic is natural in the sense of not being human-made but is hardly something you would want to eat much of. Cultured meat could be human-made, but if successfully engineered, could be far healthier than ordinary meat or no meat at all. It depends entirely on the make-up of the substance.

Some would argue that eating human-made meat is an unnatural practice that separates us further from nature. The response to this is to ask what the alternatives are and whether being too close to nature (in the sense of following our evolved instincts) is itself morally suspect. In terms of alternatives, vegetarianism is of course an option, but can vegetarianism truly hold the torch for being "natural"? Human beings' omnivorousness is part and parcel of our nature and some would argue that it is vegetarianism that is unnatural. People holding this position might also argue that we should try to be more "natural" in the sense of only eating meat we hunt ourselves, perhaps even with primitive weapons, but this would lead to a more general critique of the concept of naturalness that nature is no particular friend to individual animals. The gazelle being gnawed to death by lions and the cow being electrocuted or the deer shot by humans using bows and arrows have little to choose between in terms of their own goods. To be "natural" then, even if we could clearly define it, seems to have little promise for reducing animal suffering.[7] And given the observations made by proponents of cultured meat that our current slaughterhouse practices are hardly "natural" (Dayal 2005) we can see that our choices may not be much clarified by seeking to be "natural." If anything, the alleged "unnaturalness" of cultured meat may be precisely the thing we are looking for—some option that is not currently offered by the physical constraints of given nature. In this sense, cultured meat may be superior to what nature offers—humans can live out their natural propensity to eat meat while also sparing animals from the horrors of that propensity.

Yuck Factor

Ever since Leon Kass's call for making human cloning illegal largely as a result of the "wisdom of repugnance" or the less nobly known "yuck factor," people have paid more attention to the reaction of disgust in trying to judge whether a new, and especially biotechnological, process is morally permissible and whether it should be legally permissible (Kass 1997).[8] Two considerations arise here. First, how important should we judge disgust? Second, to what extent do people actually continue to feel disgust when educated about or familiarized with a new process?

For the first question, it is important to note that many elements of disgust are evolved reactions to dangerous things. Evolutionary psychologists have argued that reactions to cannibalism and incest and certain smells and certain visual cues (like yellow-green slime) have evolved as a result of actions or substances being biologically dangerous for us, for instance, in passing on defective genes or infecting us with parasites.[9] Disgust should not be ignored, then. However, though some disgusting phenomena may be directly related to

[7] Of course, some environmentalists may not be opposed per se to animal suffering. They may be more opposed to acting unnaturally and think that subsistence herding and hunting may be permissible. There are many positions on animal rights and animal suffering that involve differing perspectives on the value of being "natural."

[8] And of course, some emotivist thinkers have argued that moral disapproval is nothing more than the emotional reaction of disgust.

[9] http://www.bbc.co.uk/science/humanbody/mind/surveys/disgust/index.shtml (accessed May 13 2008).

evolved warning signals, some are also largely cultural. Opponents of taking the yuck factor too seriously like to mention the fact that different cultures consider different things disgusting (such as eating pork versus eating horse). They also like to point to cultural mores that themselves may be unjustified to show that disgust is sometimes used as a defense for immoral treatment (such as the disgust at miscegenation). What is important then (and Kass acknowledges this) is to use our reason to show whether reactions of disgust have some moral validity and how seriously they should be taken. What this means practically is that disgust may be a trigger for leading us to analyze something, but disgust in itself is not determinative. We must then ask those people who experience disgust at the thought of eating cultured meat if their reactions are based on something identifiably immoral or if they are simply a kind of neophobia. In the end, disgusted or not, we will have to rely on our reason to determine how to weigh disgust, and in terms of danger avoidance, there is no reason to think that cultured meat should be avoided.

For the second question, we should ask ourselves and others how strong this yuck reaction is. For example, in his article on cloning, Leon Kass responds with a profound reaction and assumes that most people share it. However, as anyone who has worked in a biology lab, or read science fiction novels, or has even taught ordinary undergraduates has seen, such a reaction is hardly universal. Students, though perhaps no fan of cloning, tend to remark that Kass's level of horror at cloning is simply strange. Others have remarked that though they felt revulsion when they first heard of cultured meat, they have since changed their attitudes. As Rina Deych says: "After much thought I have come to the conclusion that it's not about (the turning of) my stomach that's important. It's about the potential to spare the suffering of tens of billions of animals per year and, at the same time, improve human health, and reduce insult to the environment" (Deych).

As for ourselves, we can generally say that the idea of eating cultured meat does not pose much of a disgust reaction at all. Certainly it does not present us with as much disgust as we experience in the knowledge of how ordinary meat is produced or even how hunted meat is produced. In fact, we suspect that that most people who have no yuck reaction to eating ordinary meat, if exposed to a day in the slaughterhouse, or an evening at a deer hunting camp, would develop something of a significant yuck reaction. Further, we would predict that most people who have a yuck reaction to cultured meat, if exposed to a culturing process, would have their yuck reaction diminished.[10] Whatever the case, the point is that disgust does not solve the issue. Disgust reactions, though acknowledged, should be modified by rational analysis.

Technological Fix is Moral Cowardice

One argument against this whole approach is about seeking a technological fix at all. Some hold the view that looking for technological fixes is wrongheaded, even without concerns about unexpected consequences (which of course, are a problem for any course of action). Looking for a technological solution to social problems, they say, is moral cowardice—choosing a quick fix over genuine moral work.

The problem with such a claim is that it is typically backgrounded by a view of what the proper moral outcome should be and is propounded largely by people waiting for their arguments to win the day. If this happens, then fine, but in many moral debates it turns out that either argumentation is not listened to, or that there are cultural blinders that allow us

[10] As one reviewer of this article pointed out, in terms of being disgusting, the manufacturing process of cultured meat is likely to be very similar to those for producing cheese and tofu.

to ignore the truth of arguments (the disconnected nature of purchasing meat in our culture, for example). If arguments are not working, then why not change the physical reality of the situation to allow new options? In arguing for cultural change, we do not limit our moral options to conventional cultural mores, so why limit our moral options to conventional biology? And why not think that a solution mediated by technology is just as good for some purposes as a solution mediated by difficult moral argumentation? Perhaps for the purpose of cleansing our souls it is not, but such virtue-related ideals are not our only considerations. If technology can accomplish the goal of reducing animal suffering even by appealing to our selfishness, then at least animal suffering is reduced. It may also take a few years of living with something like cultured meat to help change our mores so that people in the future find eating meat from living animals unbearably barbaric.

Some will say this is ridiculously utopian—technology simply cannot accomplish such a fix. Perhaps, but human nature seems to show that the hope for a moral consensus on some matters may be even more utopian than hopes for a technological solution. In the case of animal suffering, technology really can change the physical options available and therefore really has the potential to improve the matter in a way that the hope for moral consensus never could.

Finally, many people eat meat with reluctance or with some effort to avoid thinking about how it arrived at their table. While they generally oppose animal suffering, it is easy for them to ignore it since they never confront it. For these people, the physical changes brought about by culturing technology would be a welcome moral and psychological relief.

At best then, the argument from moral cowardice suggests we should not be so naïve as to think technology can simply solve all our problems; it should not however lead us to think that technology cannot be a powerful moral tool.

Wrong Moral Motivations

A related argument against promoting cultured meat is that this would be motivated by self-ishness when we should be self-sacrificing and virtuous. That is, refusing to stop eating meat until a new technology relieves our discomfort is hardly morally laudable. We should have the moral fortitude to do the right thing even if it means some measure of sacrifice for ourselves.

There are three responses to this position. One, a purely consequentialist position is that our main goal here is not to boost our own moral self-regard or even to boost our own virtue, but to relieve animal suffering. If making use of a selfish motivation can accomplish that, then so be it. The goal is set by the suffering of animals. Two, people at the early stages of cultured meat technology would still have the choice between cultured and slaughtered meat so they could vote with their conscience and economic power over what to support, giving them some opportunity to make virtuous decisions. Three, current meat eaters are not the only people of interest here. People who are moral vegetarians would now be given the chance to indulge a perfectly acceptable preference in eating cultured meat that would not affect their virtue at all. Since cultured meat has no suffering involved, it would be perfectly legitimate to choose it. In the end then, the claim is that while eating cultured meat would not necessarily be an exercise of significant virtue, it would make things better.

Delay Moral Change

Another worry might be that hoping for a technological fix will make people more at ease with meat-eating now, will make them think they do not need to change anything now

because in the near future technology will solve their difficulties. It is difficult to know how people will be psychologically affected by the promise of future technology, but this may be beside the point. The arguments against meat eating all already stand or fall as they are regardless of what the future will hold. If any appeals to animal suffering are working, they continue to work when animals suffer, whether or not such suffering may be obviated in the future. Given the relatively small impact of vegetarianism on the meat industry it seems such appeals do not work all that well. However, it seems unlikely that working toward cultured meat would cause people who are on the verge of becoming vegetarians to remain conventional meat eaters. In any case, changing the meat industry itself would seem to hold out the promise of more animal friendly changes than to continue on our present course.

The Lives of Food Animals are Better than Nothing

One objection that is already familiar from critiques of ethical vegetarianism is that animals' lives will go better, paradoxically, in a world with something like the present meat industry, than in a world with universal or widespread vegetarianism. Suppose that meat culturing prevails, and the meat industry is in effect discontinued. What would happen to all of these animals? Livestock animals have been bred for their dependence on human beings, and would fare poorly without this ongoing husbandry. In North America, to take one example, livestock animals are not former members of non-human ecosystems into which they could be integrated once having been released from their use as food. One can easily imagine scenarios of mass deprivation, death, and ecological disruption resulting from the shift to a meat culture world.

This objection depends on the implausible empirical assumption that the transition from an animal-based to a cultured meat economy would take place suddenly and without warning. It is much more plausible to suppose that it would take a generation or more, and that for extended periods of time, cultured meat and animal meat would coexist in the marketplace. So long as these markets exist, cattle, chickens, pigs, and so on will be valuable commodities, and hence no rational owners would discard them as waste. During this transitional period, there would be plenty of time for a deliberate restructuring of the industry and the practices of husbandry that make it possible. Presumably the breeding and sale of livestock animals could decline in a predictable fashion in response to changing consumer demand. The most likely scenario, therefore, is that the population of livestock animals would decrease because of a diminishing rate of replacement of slaughtered animals by new animals, eventually ending in a situation in which no new animals are born for slaughter.

In light of this more plausible empirical prediction, the objection could be reformulated as follows. The eventually realized world of cultured meat will be worse for the livestock animals because they will never be born in the first place! If one cares about the flourishing of livestock animals, one should prefer a world in which there are millions of these animals (admittedly enduring some suffering) to one in which there are none. This objection treads on some shaky metaphysical ground. There has been relatively little exploration by contemporary ethicists of the morality of creation; namely, the question of the extent to which we might have moral reasons to bring a being into existence, where those reasons are in some important sense generated by the being itself. However, it is difficult to see what could be wrong with the decision to refrain from creating. For at the time of the decision, there exists no creature that would be harmed by that decision, nor any creature whose good we are failing to consider or promote, and no creature to which we could have

obligations. This is not to say that there could never be compelling moral reasons to create a creature, but only that these reasons, whatever they may be, could not be generated by the interests of that (non-existent) creature. This holds true even if on the whole, existing farmed animals enjoy life more than they suffer (a questionable assumption). In this case, there would still be no obligation to any creature to bring it into existence, because the very non-existence of the creature (a tortured concept and phrase at best) precludes there being an object of the obligation. In any case, nothing in the cultured meat proposal requires that cows, chickens, pigs, and so on be allowed to pass into extinction. In many cases, they might continue to be used in humane dairy production, or as something like pets or companion animals.

Finally, yet another reformulation of this argument might be that animals have intrinsic value and we always do something good when contributing to the existence of or causing the existence of such animals (or other things) because doing so increases intrinsic value. This version of the argument depends on both the existence of intrinsic value, which is a highly contested concept, and on the view that increasing intrinsic value is always, or mostly, good. Even accepting for the sake of argument the existence of intrinsic value, what are the limits of our obligation to create more things with intrinsic value? Should we reproduce ourselves as much as possible because humans have intrinsic value, or should we breed as many animals as possible to increase intrinsic value? Most believers in intrinsic value would say there are limits to such creation. More is not necessarily better. But what would be the limiting factor? If it is that too many intrinsically valuable beings can exist, upsetting the balance of population and resources and causing die-offs, then we apparently have the notion of there being some fairly specific number of intrinsically valuable beings that the earth can contain—a sort of moral carrying capacity. If there is such a thing, cultured meat would not prevent us from continuing to breed domestic animals to meet this capacity. It would only allow us both to meet this capacity and not kill the animals for food—a situation which would not decrease intrinsic value but would still decrease suffering.

If, however, the limiting factor for creating more intrinsically valuable beings is that too many beings leads to suffering, then the phenomenal experience of beings is the key. In such a case, suffering weighs in as a factor that must be considered along with intrinsic value. In this view, cultured meat would still be useful, because it could reduce suffering, while having no specific impact on the obligation to keep animals alive and breeding. We could still breed the requisite maximal number of animals and yet not kill them or subject them to painful practices for the purpose of producing food.

In short, all cultured meat would do is eliminate the need to kill animals for food. All other considerations of intrinsic value and animal experience could be pursued independently. The only objection to using cultured meat along these lines would be if someone believed humans had a moral obligation to kill animals for food and that cultured meat would interfere with this obligation. Short of a few interpretations of sectarian religious views, we are aware of no one who believes in such an obligation.

Taint of the Source

Another argument is that any cultured meat will use original cells gathered from some animal in a morally suspect way and that the use of such cells will morally taint all future generations of tissue (Hawthorne 2005). The first response to this is that the concept of moral taint being passed along through the physical connections between generations, like

the theological doctrine of original sin, works with a largely mysterious mechanism. How exactly is immorality passed down the line? Like non-consequentialist concerns with original sin or Nazi medical research or blood money or using organs from murder victims for transplants, it is never made clear how a moral stamp, good or bad, is transferable. However, if it is the case that significant numbers of people would believe in such a transferability of moral taint, then the situation could easily be remedied by taking cell samples in a painless biopsy-like way rather than killing any original animal. While some discomfort might be unavoidable, the enormous good that could come from a short, simple, undamaging procedure would seem to overwhelm any criticism—that is, if the practical alternative was to keep the meat industry as it is. As Tom Regan is quoted as saying: "If…no injustice is done in the procurement of the cells, then it's more difficult to lodge an objection rooted in respect for animal rights…I don't at present see why [animal rights activists] would have to be against in vitro meat on moral grounds." (Hawthorne 2005).

Animal Integrity

One novel consideration brought up for the purposes of exonerating some people's moral intuitions that animals should not be biotechnologically altered is that of "animal integrity." In regards to a suggestion that chickens might be genetically altered into insentient lumps of flesh, producing eggs and meat, some have argued that such alterations are intuitively wrong and this sense of wrong can be captured by the idea that the integrity of the animal has been violated. This notion is defined as: "An animal's integrity is violated when through human intervention it is no longer whole or intact, if its species-specific balance is changed, or if it no longer has the capacity to sustain itself in an environment suitable to its species (Bovenkerk et al. 2002, p. 21).

On one level, a critic could argue that this notion of integrity appears to be little more than an ad hoc moralism devised to justify technophobic intuitions. However, the integrity argument in some ways does not even need to be examined here because in the kind of tissue culturing we are encouraging, the concept of animal integrity violation simply would not apply. The reason is that no animal is being changed into anything, and that the resulting creation of biotechnology is not an animal, new or otherwise. The kind of situation that the defenders of integrity seem to be imagining focuses on altering existing animals in such a way as to create a new type of insensible organism. In tissue culturing, however, the animal that provides the source cells is not altered and the resulting tissue culture is not a new type of organism. There is nothing to have or not have "animal integrity" in the tissue culture. It is stand-alone meat. Real meat, but not an animal.

One could probably extend this analysis even to the case of genetically engineering insensible egg-laying lumps by simply making the process one of creating the pseudochicken consist of genetically altering gametes. This would ensure that no actual animal was turned into a pseudochicken but rather that the pseudochicken was created as is from mere cells.

Now, if the questionable concept of animal integrity is supposed to be so extensive as to say that integrity is violated by the very fact of using genetic material to create something that is partially genetically a chicken but not organismically a chicken—that the creation of such a thing somehow violates the integrity of the various species of chicken, then our response would be twofold. One, the proper object of moral treatment is individuals, not species or other minimally realistic, insentient universals. There is little sense to be made of the idea that chicken-as-species is somehow violated in

creating a pseudochicken. Two, no animal is harmed or even disrespected by creating an insentient pseudochicken or chicken meat tissue culture. Any remaining "intuitions" that creating such meat is wrong probably reflect nothing more than unexamined repugnance.

A Lack of Moral Regard, Dignity, and Respect

Another kind of objection might be that enjoying vegetarian meat is wrong (even though no animals are harmed) for the same reason that eating cultured human flesh would be wrong (even though no humans would be harmed): it demonstrates a lack of moral regard for the kind of creature in question, by objectifying, commodifying, or instrumentalizing animals in an objectionable way, by ignoring their dignity and failing to treat them with proper respect.

The idea here is that animals have a certain type of moral status and the process involved in creating and using cultured meat violates that moral status. To respect a creature we must not treat it merely as a means; e.g., a source of consumable parts as in cultured meat schemes.

The first response to this is a consequentialist one: the conventional meat industry is even worse in this regard because it treats the entire being, not just some derivatives, as a mere means. Of course, this reply is partially an instance of the tu quoque fallacy, but it is relevant insofar as veganism is not a live option for actual human societies as they now stand and the real choice is therefore between cultured meat and slaughtered meat.

The second response is more complex but gets more directly at the concerns with dignity and moral regard. In using in vitro meat one would not be instrumentalizing an animal but rather would be instrumentalizing cells and tissues. While there might be objections as to how the source cells are obtained (but with many available means of painlessly and harmlessly obtaining sources cells, this could presumably be avoided and is not the issue in moral regard in any case), once the cells are obtained, it is the resulting, newly grown, disembodied, dis-integrated cells and tissues that are being used for nutrition and eating pleasure. The cells have ceased to function (or for most of them, never did function) as part of any individual animal (and the animal from which the cells came may be perfectly happy and pursuing its own good). The only ways one could object to this would be to argue that either the animal is being regarded as merely a source of cells or that the cells themselves deserve some sort of specific moral regard.

In the first case, the animal may be seen by some individuals as merely a source of cells but certainly does not have to be. A partial model for this way of looking at the animal is the use of wool: we can shear sheep and use their wool for fabrics while showing all due regard for their well-being. Imagine on top of this that a sheep only needs a few bits of its wool removed and then a self-replicating line of wool can be produced and you have an even more morally acceptable system. Consider also that when humans are used as sources for cells (in blood, or stem cell, or bone marrow transplants), they are not thereby relegated to mere instrumentation. They continue to be regarded as beings with their own pursuable goods.

In the second case, to claim that the cells themselves deserve respect and moral regard would stretch the limits of respect to fetishistic standards. Cell and tissues are nonsentient and function normally only as part of larger organs, not individually. They thus have neither a claim against moral agents based on how they feel, nor do they have any claim against moral agents based on their pursuit of their own good. They have no good of their own but only exist normally in relation to a greater organismic structure. To argue that they

should be treated with individual moral regard ignores their nature and provides no more or less reasonable objection than to argue that blood transfusions are immoral because they fail to respect the dignity of and moral regard due individual blood cells.

In essence, this is to say that extracting cells from an animal does not imply that one sees it only as a cell source—in fact the very motivation behind much of in vitro meat research is generated by seeing animals as worthy of much more regard than being merely food sources. This is also to say that cells themselves as individual units are not properly seen as objects of distinct moral regard because they are not sentient, and normally function only as part of a larger organic, holistic systems anyway.

This is not to say that the moral regard objection does not point to a tension. It is the case that vegetarian meat is attractive (from a moral point of view) precisely because it has almost nothing to do with real sentient animals, but it is also the case that vegetarian meat is attractive (from a consumer point of view) precisely because (unlike meat substitutes) it is real animal tissue. What we should recognize in this new technological situation, however, is precisely that *meat* can be divorced conceptually from *animal*. While in vitro meat is in some sense an animal product, it does not have to be an animal part. In fact, what in vitro meat would do is to create a new physical reality that actually does match up with the self-deceptive and self-serving situation many consumers already imagine when they buy meat at a grocery store. Consumers pretend meat is a disembodied material that does not have its source in a killed, feeling, animal. With in vitro meat, however, this disembodiment is real rather than imagined and is morally relevant. In vitro meat can justifiably be reconceptualized—real meat but not a real animal part. There is, then, no problem with moral regard. Meat has no claim on moral regard for itself, and in vitro meat is not connected to any whole animal that does have a claim for moral regard in any morally prohibitive way.

Dominion Versus Reverence

A final, more sweeping version of the objection from respect and dignity, which applies to many different types of technological manipulations, goes like this. To revere a creature (or perhaps the world in general) we must accept what is given about it rather than transforming its nature. In this connection, cultured meat represents (to use as one example, the terms of Michael Sandel's argument in "The Case Against Perfection") the triumph "of willfulness over giftedness, of dominion over reverence, of molding over beholding" (Sandel 2007, p. 85). While Sandel's argument is about genetically engineering humans, we think the general tone of his work captures what a number of different writers would object to. There is a revulsion against trying to force the world to adapt to our desires and preferences rather than doing the hard social moral work of adapting our desires to the world and navigating the complexities of relationships with other people who have different desires and perceptions. Seeking a technological fix is, then, arrogant.

Part of this concern may be another version of the "against nature" objection, to which we have already spoken, arguing that what is natural is not the same as what is good and we can easily imagine and then realize adjustments to nature to make it better than what it was for the lives of sentient beings. Part of this concern, however, seems to be different than the nature argument because rather than focusing on the intrinsic moral value of nature and naturalness, it focuses on a kind of virtue-related issue in which the moral attitudes of human beings are the things at stake. Respecting, and deferring to what is given in the nature of things then, is a way to express, shape, and constrain human moral attitude.

As Sandel argues, the reason for deferring to what is naturally given is that if life is not taken as a gift but rather as an object of will, we lose appropriate humility and attempt to assume moral responsibility for too much of the created world.

Our response is that while humility may in many ways be a virtue, false humility or quietistic humility is not. Like many a gift from human beings, nature possesses imperfections that make the "gift" a mixed blessing. Unlike many a gift from human beings, however, nature may actually harm us or those other sentient beings we care about. Why should the insensible givenness of nature trump our entirely natural and understandable desire to make life better for sensing beings? Why should our desire to be humble trump our desires to reduce suffering? If we are reasonably confident that we can successfully exercise control over some portion of nature, and we recognize compelling moral and prudential reasons for doing so, then to refrain from doing so out of humility would be more self-indulgent than humble, more complacent than courageous. From this point of view, it seems that the objection from dominion and reverence cuts more against slaughtered meat rather than cultured meat. For under the current system, our responsibility for suffering caused to animals is so widespread and overwhelming that when presented with it, many of us are inclined to throw up our hands. After all, if it is practically impossible to avoid causing suffering for food, why even try to avoid it? The responsibility placed on us in supporting a system of cultured meat is, by contrast, entirely manageable and thus appropriate.

Conclusion

Cultured meat has the potential to make eating animals unnecessary, even while satisfying all the nutritional and hedonic requirements of meat eaters. It also has the potential to greatly reduce animal suffering. As such, the development of cultured meat would seem to have a moral claim on us—whether moral vegetarians (for whom a greater opportunity exists to reduce animal suffering) or conflicted meat eaters (for whom practice could now cohere with beliefs) or even for recreational hunters (for whom ancillary arguments about providing food would fall by the wayside and require defenses of getting pleasure from animal death per se). The development of cultured meat, then, is not merely an interesting technological phenomenon, but something that we may be morally required to support. In doing so, we recognize that morality is not something that must simply respond to new technologies as they arrive, throwing us into confusion, but rather that morality may champion and assist in the development of new technologies, as a step toward the production of a world that in fact, and not merely in ideal, mirrors the moral vision we possess for it.

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