

Flesh Without Blood:

The Public Health Benefits of Clean Meat

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Abstract:

Synthetic meat made from animal cells will transform how we eat. It will reduce suffering by eliminating the need to raise and slaughter animals. But it will also have big public health benefits if it becomes widely consumed. We discuss how “clean meat” can reduce the risks associated with intensive animal farming, including antibiotic resistance, environmental pollution, and zoonotic viral diseases like influenza and coronavirus. Since the most common objection to clean meat is that some people find it “disgusting” or “unnatural,” we explore the psychology of disgust, and compare the potential reluctance to consume clean meat with resistance to genetically modified food. We end by arguing that the public health benefits of clean meat give us strong reasons to promote its development and consumption.

Key words: clean meat, animal welfare, antibiotic resistance, zoonotic disease, synthetic meat

1. Public Health and Animal Agriculture

Our ancestors relied on a steady diet of meat.¹ It is now possible to substitute a carnivorous diet with protein derived from plants, but it can be tricky to design a plant-based diet that contains the complete range of amino acids and minerals needed for a healthy human life. Consuming meat from slaughtered animals is still the easiest and often the cheapest way to meet our dietary needs and satisfy our taste for traditional animal meat.

But things are changing. Along with new plant-based products that mimic the texture and taste of meat, biomedical engineers can now take either stem cells, or adult animal cells, and induce them to replicate until they become a slice of meat. Creating a steak, with its intricate marbling, is challenging. Creating ground beef or chicken nuggets is more straightforward. So straightforward that in 2020 Israel opened the first clean meat restaurant in human history. Offerings are still quite limited, but the restaurant’s meat suppliers provide proof that some forms of clean meat can be made affordable. Enhancing the nutritional profile of meat is likely to be as feasible as enhancing its taste and texture, though it is still an open question whether this process can scale in a way that would make complex cuts of meat – as opposed to ground beef or uniform slabs of chicken – affordable to everyone.²

¹ Some even credit increased meat consumption with the rapid evolution of large brains (Aiello and Wheeler 1995).

² For an overview of the scientific challenges of creating clean meat, see Ben-Arye and Levenberg (2019). For a less technical overview, see Bombardner’s (2018) article, or Paul Shapiro’s (2018) book-length account of the subject.

Meat consumption continues to grow around the world, and not just because of population growth. Wealthier people tend to eat more meat (Ritchie and Roser 2019). And although a small percent of people in the most prosperous countries in Europe and North America have turned to vegetarian diets, most are consuming more meat than ever. Some question whether we can ever justify killing animals for consumption, while others worry more about the *ways* in which animals on factory farms are raised and slaughtered (Singer 2011, ch 3). But unless a remarkable change of dietary norms occurs, or clean meat becomes widely consumed, it is likely that intensive animal farms will grow in the present century, especially in poor countries. With the growth of factory farms comes an increased risk of antibiotic resistance and, more importantly, zoonotic diseases, which occur when non-human animals transfer pathogens like influenza and coronavirus to people (Anomaly, 2015).

Animals raised in the cramped conditions of factory farms are often given a steady dose of antibiotics to avoid disease and promote growth. This gives rise to antibiotic resistant bacteria, which make their way into our general microbial environment, including human households and hospitals (Marshall and Levy, 2011). Although it is difficult to quantify with precision, experts estimate that about half of all antibiotics in the world are given to farm animals (O'Neill, 2015). If animals were given more roaming space, they wouldn't need antibiotics. But it is often more profitable to raise animals in factory-like conditions, ignoring the cruelty imposed on them, and public health costs imposed on people. While European and other Western nations have begun regulating and discouraging the use agricultural antibiotics, their use is skyrocketing in places like China, India, and North Africa (Tiseo et al 2020).

A recent example of antibiotic resistant strains of bacteria arising on factory farms and spreading to people occurred in China. Samples of bacteria on intensive animal farms in China show a spike in resistance to colistin, which is a powerful, last-resort antibiotic important for human health (Liu et al 2016, Xu et al 2018). This is one of many strains of antibiotic resistant bacteria that have either arisen from, or have been exacerbated by, the use of antibiotics in animal agriculture (Rinsky et al 2013, Cuny et al 2015, Spellberg et al 2016).

Even if we were to end the use of antibiotics in animals, zoonotic diseases are an intrinsic risk associated with animal agriculture. Factory farming only intensifies this risk. There are several ways deadly microbes are transmitted from non-human animals to humans (Greger 2007). One is from consuming animal meat, especially if it is raw or undercooked. Another is by humans changing their ecosystems in ways that expose them to environments that contain deadly pathogens. For example, malaria is transmitted by mosquitoes that breed near stagnant water that humans might use as a source of drinking water for themselves or their farm animals. Lyme disease and plague are contracted from rodents that feed off the scraps of food they find in densely populated human settlements. Domesticated animals living in densely packed environments near people can transmit diseases to us even if we don't eat them.

As Dorothy Crawford documents, the agricultural revolution improved food security and social stability, but dramatically increased infectious diseases in human populations:

For the first time people were living in close contact with herd animals—drinking their milk, butchering and eating their flesh, curing their skins, caring for their young and sick, and sharing their shelter. Many animal microbes took the opportunity to jump ship, finding a new niche in a virgin human population... There is now no doubt that most of the microbes that cause the classic acute childhood infectious diseases, such as smallpox, measles, mumps, diphtheria, whooping cough and scarlet fever, were originally exclusively animal pathogens that at some time in the past crossed the species barrier to infect humans. Today they only infect humans but their DNA sequences

contain the tell-tale signs of their past lives. Their closest relatives are among the microbes of domestic animals, and in some cases the molecular clock even pinpoints the timing of their transfer to the early farming era (2018, p. 60).

While zoonotic diseases have been afflicting us for a long time, factory farming creates conditions that intensify the risks of novel forms of these diseases (Crawford 2000). Antibiotic resistant bacteria and zoonotic viruses that spread from domesticated animals to humans impose invisible costs on people around the world that are not included in the purchase price of meat. Animal farming also requires more space (often obtained by cutting down forests) and more energy inputs than the production of clean meat (Tuomisto and de Mattos 2011). By contrast, clean meat will allow us to enjoy the taste of traditional meat from animals without imposing health costs on other people and cruelty on animals (Fleischman 2021).

2. Animal Suffering [Walter and Heather]

Along with concerns for human and environmental health, there are of course those for the animals themselves. Indeed, perhaps the strongest driving factor for a reduction in the consumption of animal products has been a concern for the welfare of animals used in agriculture, particularly intensively managed or ‘factory farmed’ animals. Many modern farming practices create suffering through husbandry and slaughter practices. Awareness of the welfare problems associated with factory farming was first raised by Ruth Harrison in her 1964 book *Animal Machines*, issues that were further brought to popular attention by Peter Singer in 1975 with the publication of *Animal Liberation*. These books, and others since, have highlighted the range of ways in which intensive farming causes suffering to animals: broiler chickens spending their life indoors with no natural light and less than a square foot each, their beaks partially removed with hot blades to decrease aggression in these crowded conditions, and suffering deformities and lameness from overly rapid growth; sows kept in tiny stalls that don’t permit them to turn around or provide a soft place to sleep, with limited cognitive and behavioral opportunities provided for them to exercise their physical and cognitive needs (Gruen 2011, Harrison 1964, Singer 1975). With over 70 billion animals³ farmed annually for human food production, and around another 1-3 trillion fish⁴ caught per year, this is a considerable amount of suffering.

Apart from the suffering caused by improper housing, there are welfare problems with slaughter. Transporting, processing, and killing farm animals are often sources of pain, discomfort and suffering, with even the best-run slaughterhouses facing failure rates in stunning, leading to millions of animals being processed while still conscious (Lamey 2019). Even if some slaughterhouses try to minimize these negative effects for animals, little if any attention is given to positive experiences. The mere absence of pain is not the same as a *good* life. There is also the moral concern raised by the very fact of slaughter itself, which on many accounts of animal welfare, will reduce welfare through the shortening of life and removal of future opportunities for pleasure (Browning & Veit 2020).

Utilitarians are especially concerned with minimizing suffering. But other ethical views emphasize the rights of animals, including the freedom not to be used for human ends without sufficient justification (e.g. Regan 1983). The very acts of farming and slaughtering animals – especially in intensive farming operations – are acts of cruelty towards animals, over and above the suffering caused. Across a range of views, as well as public opinion, it is generally accepted that animals possess

³ <https://www.worldanimalprotection.org.au/our-work/animals-farming-supporting-70-billion-animals>

⁴ <http://fishcount.org.uk/fish-count-estimates-2>

at least some moral standing and, all else being equal, it is important to consider their welfare. This is particularly true for captive animals, where humans are entirely responsible for the conditions and quality of lives of the animals in their care.

The reason these issues raise moral concerns is because of the *experience* of animals. Many animals – including all the vertebrate animals used in agriculture – are sentient, meaning they are capable of experiencing positively and negatively valenced mental states such as pleasure and pain. It is this experience that grounds our moral concern for their treatment (Browning 2019). This was famously and eloquently proclaimed by Jeremy Bentham: “The question is not, Can they *reason*? nor, Can they *talk*? but, Can they *suffer*?” (Bentham, 1879, p. 309). This concern for the experience of animals can be seen throughout a range of ethical views, such as the utilitarianism of Singer (1975), the interest-based rights views that ground interests in the capacity for pleasure and suffering (e.g. Beauchamp 2011, Cochrane 2012, Gruen, 2011) and even some virtue ethicists, who see recognition of sentience as giving rise to virtues such as compassion and respect in our interactions with them (Hursthouse 2011). It is also a strong focus of much of the work in animal welfare science (e.g. Dawkins 1980⁵, Fraser 1999, Mellor et al. 2020). The general claim is that having the capacity for first-person experience makes sentience morally significant: “It is the fact that sentient beings care about how their lives go that generates a distinctive moral claim on us” (Donaldson & Kymlicka, 2011, p. 33).

Any animal that is sentient is capable of suffering and this gives us moral reason to want to avoid these states. Whichever ethical views one holds, it is clear that intensive animal farming results in a large degree of animal suffering. Although there are alternative systems of meat production – often called ‘humane farms’ – that cause less suffering, these are typically considered unsustainable for affordable production of animal products at the current scale of consumption (Singer 2011). By contrast, lab-grown meat is a simple insentient tissue, incapable of suffering and thus its production does not raise these same moral concerns. Use of lab-grown meat in place of animal agriculture will thus significantly reduce, if not eliminate, the amount of suffering caused through food production.

Despite the obvious benefits of eating clean meat, many people find the idea of eating meat made in a lab “disgusting” or “unnatural.” We will therefore explore the psychology of disgust, and consider whether it is a reliable guide to ethical behavior.

3. The Psychology of Disgust [Jonny and Diana]

People are disgusted by many things, including smells and tastes in food that indicate the presence of infectious disease. These reactions have been selected for indirectly by evolutionary forces that killed those of our ancestors who were willing to consume foods that contained pathogens. Of course, our ancestors had no ability to directly detect disease-causing pathogens in the plants or animals they ate. Instead, natural selection would have rewarded the ability to detect dangerous foods by allowing us to taste or smell or see indications of disease.

Our sense of disgust seems to be tied up not only with pathogen detection, but also with moral outrage (xx, yy). There is nothing wrong with this, of course, and since evolution is path-dependent, we would expect the neurological basis of disgust and other moral emotions to have a common origin with more primitive parts of our brain. The problem is that just as disgust can misfire, by being triggered by cues that don’t actually indicate the presence of pathogens, it can also be triggered by social cues that don’t indicate danger (xx, yy). For example, many people are

⁵ Though in more recent work, Dawkins has moved away from this view to a focus on animal health and preferences (Dawkins 2017).

disgusted by homosexuality despite the fact that many people upon reflection do not think we should condemn or fear homosexuality (xx). Similarly, people are strongly disgusted by incest, and even when we tell them that those having an incestuous relationship are using contraception, so that there's no chance of them producing a genetically impaired child. This automatic response, and inability to justify our sense of disgust, is known as "moral dumbfounding" (zz).

Our ability to explain why disgust exists, how it evolved, and what kinds of things and actions it is directed at, does not justify it. While many of our evolved predispositions are reliable indicators of people and things to avoid. Others cannot be trusted, as the homosexuality example is supposed to indicate. It is important, then, to separate out the predispositions and heuristics people use that can be rationally justified, given widely shared moral goals, from those that cannot be justified because their deployment fails to indicate outcomes that produce negative consequences. Another way of putting the point is this. Philosophers often speak of "the naturalistic fallacy," which is the immediate inference from the belief that "X is unnatural" to the reaction that "X is wrong." While it is true that this *automatic* inference is a fallacy, our disgust reaction to extreme novelty was selected for in ancestral environments, and it might be reliable to some stimuli in our contemporary environment as a general heuristic (Gigerenzer and Brighton, 2009). For example, while sewage plants and beer breweries are new inventions, the sense of disgust we get when we smell sewage correctly suggests we should distinguish between drinking from the tanks of breweries and gulping gallons of sewage at sanitation centers.⁶

--Disgust as a heuristic (why it's not reliable in cases like this, analogy with GMOs, see *Sentience Institute* report on fear of GMOs, advice on how to roll out "unnatural" products with public support)

4. Collective Action [Jonny]

We've argued that there are good reasons to consume clean meat in order to promote public health and reduce animal cruelty. But the public health benefits associated with clean meat are largely a function of *how many* people make the switch away from animal consumption and toward either clean meat or plant-based protein. There may be some reluctance to switch to clean meat to the extent that the benefits of consumption accrue mostly to other people, while the costs are borne by the individual consumer. The costs might be monetary (until the price of clean meat falls) or aesthetic (to the extent that the appearance or texture differs from traditional meat). In other words, for those who aren't already excited by the prospect of eating clean meat, the shift from consuming traditional meat to clean meat may generate a collective action problem.

Collective Action Problems (CAPs) occur when there are benefits to a group from each of their members contributing to some collective good, but when there are incentives for each to refrain from contributing. CAPs are close cousins of "public goods" problems or "commons tragedies" in economics, and are often modeled by game theorists as multi-player prisoner's dilemmas or assurance games. Which model we use to capture a CAP depends on the motivations of the people we're modeling, and on what we think the collective benefits and costs of their actions are likely to be.

If clean meat scales in a way that it becomes as cheap and health as "natural" meat, and if it also has collective health and environmental benefits, we might expect everyone to change their

⁶ One of the authors used to disregard this natural reaction, and continually got sinus infections after surfing near a sewage treatment plant in Los Angeles.

eating habits and consume it. But this is not necessarily true. First, as discussed above, many people might need to overcome their resistance to what they regard as “artificial” food. We think this is likely to happen as clean meat becomes cheap, is understood to be healthy, and social norms change. But the second reason people might resist clean meat even if the collective benefits are large is that we often ignore the external costs or benefits of our consumption habits. When the consequences of our actions are borne by other people, we often fail to include them in the implicit cost-benefit analysis each of us does before we act. For example, when we think about which road to drive on in order to get home quickly, we fail to include the cost we impose on others by *increasing* congestion on one road and *decreasing* it on other roads. When each of us discounts these external effects, it makes little difference. But when all of us do so, the aggregate effect is big – it is the difference between heavy traffic and light traffic.

In the case of traffic, it’s hard to know what the total effects of our decisions are likely to be. So it’s both rational and morally excusable to ignore these effects. However, in the case of other aggregate harms, like the air pollution we cause when we use certain sources of energy, or the public health risks we impose when we consume meat from factory farms, the consequences of our choices are a little clearer. It’s true that in any given case of contributing to a pollution or public health problem, we are unlikely to impose any discrete harms on other people. But it’s also true that in cases like this we are imposing probabilistic harms on others, especially when many other people make the same choices.

Our moral psychology evolved to solve small-scale collective action problems. Our ancestors constantly faced situations in which they could contribute to a collective good, such as banding together to hunt large animals, or free ride on the efforts of others. Moral emotions like shame and guilt for violating pro-social norms, and esteem and pride for following pro-social norms, facilitate the emergence and stability of cooperation (Bowles and Gintis 2013). But our moral psychology tends to be more effective in getting small groups to cooperate, especially when the harms from not cooperating are immediate and easy to detect. But when harms are invisible, diffuse, and probabilistic, people tend to ignore them. Worse still, people are perfectly *rational* (in the economic sense) to ignore such harms.

To the extent that rationality involves using our time and energy to efficiently satisfy our goals, it makes little sense for ordinary people to try to figure out the total consequences of their actions – whether they’re contributing imperceptibly to traffic on the freeway or pollution in the air or public health risks like antibiotic resistance. It’s virtually impossible for us to calculate the external harms and benefits of our actions, and in many cases we are unlikely to make a significant difference to a cumulative outcome through our individual actions. For example, if I buy a single slab of roast beef from a butchered cow raised on a factory farm, and thereby slightly increase demand for factory farmed meat, my individual action is unlikely to impose public health risks on other people. Because most people implicitly understand this, they don’t investigate the connection between eating factory farmed animal meat and zoonotic viruses or antibiotic resistant bacteria.

For this reason, we think it is important to focus on how to harness social norms, information, and marketing to help nudge people from the individually rational to the collectively beneficial action.

5. Marketing Clean Meat [Diana]

Ideas for topics to cover:

Naming

e.g. in vitro meat, synthetic meat, etc (psychology of framing effects on consumer behavior). Ethics of renaming things to alter actions. Generally we disagree with changing a name simply to manipulate, or try to constrain thoughts. But as long as it's voluntarily done, there's nothing wrong with altering perceptions through branding. If the government does it, we might see it as a form of libertarian benevolence (not constraining freedom, but subtly shaping the epistemic environment to get people to act in ways that yield public health benefits).

How to label clean meat and other synthetic foods in a way that's accurate and morally justifiable. Want to convey risks (if there are any) but also potential benefits (including those mentioned above). There is precedence for this: cosmetics and cleaning products routinely brag that they did not use animal testing. In the case of food, the common labels "humanely raised" and "organic" (in the USA) convey a certain amount of information about animal welfare and potential public health benefits.

Marketing

If it's marketed in the right way clean meat could become a **luxury good** at the beginning, in the same way vegan products are status symbols in university towns.

Marketing could help mainstream the product and lower the price. But in the long run, it's more important (and perhaps more likely) that lower income people will be most likely to turn to clean meat, along with people who are in a hurry to consume protein or cheap food in the form of something like the McDonald's products "chicken nuggets" and hamburgers.

Even animal rights advocates who hate the thought of eating flesh might be more willing to consume clean meat if it's viewed as a collection of essential amino acids, no different than the ways in which plants string together amino acids that vegetarians people already consume.

Policies

Incentives to bring to market, potential **penalties** for not using it⁷ (e.g. taxes on conventional meat, antibiotics used in agriculture, etc)

See comparison of GMO and clean meat from Sentience Institute

Conclusion

⁷ First clean meat restaurant opens in Israel:
<https://www.jpost.com/health-science/worlds-first-lab-grown-meat-restaurant-opens-near-tel-aviv-649762>

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From Veit and Browning:

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