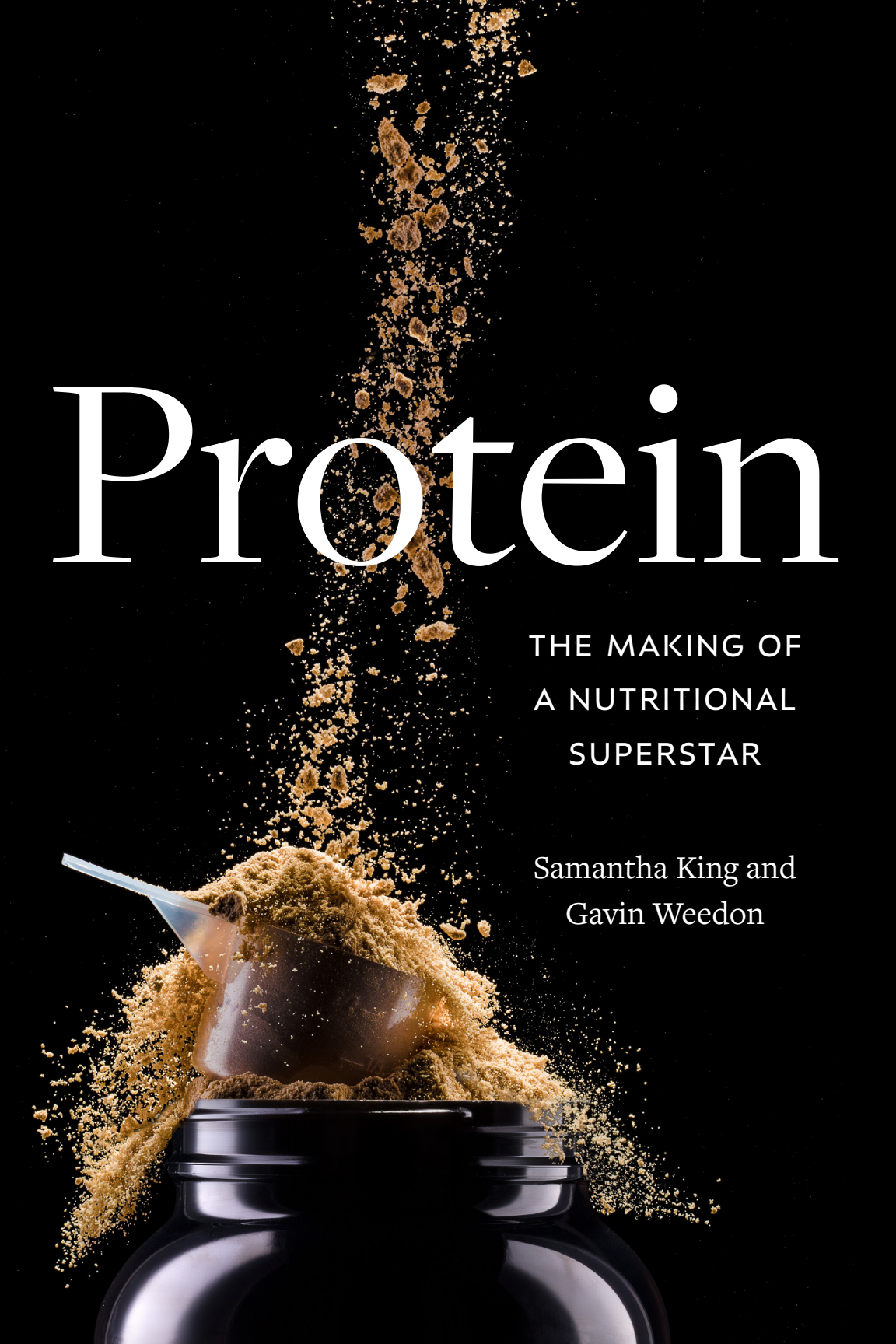
Protein
THE MAKING OF
A NUTRITIONAL
SUPERSTAR
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INTRODUCTION: PROTEIN

A Solution in Search of a Problem

In the contemporary nutritional imagination, protein assumes center stage. Touted as a muscle builder, a weight-loss aid, an antiaging fix, and more, this dietary superstar is the subject of an inescapable cultural preoccupation, even for the most hardened of skeptics. We count ourselves among the latter. As critical scholars of health and the body, questioning disciplinary edicts about what to eat is our bread and butter. But when we noticed that we, too, were getting caught up in the "protein talk" that pervaded the fitness cultures to which we belong, we began to think more carefully about the origins of this particular obsession and what it represented. While we were curious about the longer history of protein's preeminence, our initial questions focused on its current status: What is the appeal of those giant plastic tubs of highly processed protein powder for our well-fed, "clean eating" gym buddies? Why do food manufacturers emphasize the protein content of their products in increasingly larger fonts? What keeps consumers rotating through the latest high-protein dietary regimen, from Atkins to paleo to Dukan? Who needs protein added to their beer, potato chips, or ice cream? Why are people scared of carbs?

Among our most pressing questions was how to situate the fixation on protein in relation to widespread concern about the role of industrial animal agriculture in the climate crisis.[1] As global meat and dairy production contin-

ues to rise, its impact on greenhouse gas emissions, deforestation, pollution, biodiversity, animal welfare, and human health has prompted growing calls for a "protein transition" away from resource-intensive farming. The popularity of plant-based diets in traditionally meat-centric locales—including the United States and Canada, where our focus lies—is indicative of this push. But if anything, the specter of protein deficiency looms even larger in vegan discourses, or at least in the marketing of industrial plant-based foods, where the promise of high-protein content is requisite, perhaps offered as reassurance to consumers unable to imagine adequate sustenance in the absence of animal flesh. The all-caps guarantee of "20G OF PLANT PROTEIN PER SERVING" that appears in every instance of promotional material for the Beyond Meat burger exemplifies protein's allure across dietary regimes and ethical registers. In the alt-meat world, it is less high-protein diets that garner scrutiny and more the specific ingredients they contain. This orientation aligns with the growing interest of large food conglomerates in alternative protein production and their efforts to rebrand themselves as suppliers of "sustainable protein" rather than makers of meat.[2]

Gifted with a halo effect brighter and more enduring than any other category of nutrient, protein can do no wrong. The climate crisis might be motivating efforts to rethink meat, but not the foremost place of protein in our diets. Unlike with carbs or fats, there is little room for the notion of "bad" proteins in nutritional discourse. While low-fat and low-carb diets are ubiquitous, low-protein diets are virtually unheard of outside the specialized medical realms in which some patients with impaired liver or kidney function are treated. With its "near-universal" attraction, protein has become a multipurpose fix.[3] As one food marketing director puts it, "Protein's continued growth is driven by the fact that it appeals to all demographic groups. . . . Fitness for Millennials and Gen Xers, energy and weight management for boomers, wasting and muscle loss prevention for seniors."[4] The sociological subtexts of this message? In cultures of overwork, exhaustion, and anxiety, protein is understood to fuel vigor and vitality, despite the scientific consensus that carbohydrates are the body's primary sources of energy. And in antifat and ageist cultures obsessed with body size, shape, and composition, protein is a win-win prospect, especially for corporations that can sell the same protein-fortified products to groups of consumers with opposing goals: Want to lose weight? Eat more protein! Want to bulk up? Do exactly the same thing![5]

Going into the project, we imagined that these seemingly magical properties might relate to the conventional idea, rooted in biochemistry, that proteins

FIGURE 1.1. A multipurpose fix? Protein at the grocery store. Illustration created by Shawn Forde.

are the "building blocks of life" and that proteinous foods are essential for human bodies to grow and repair. We weren't wrong—protein's known and hypothesized biochemical capacities are crucial to its contemporary cultural allure and economic value. Yet we have also come to realize that after almost two centuries of research, there is little scientific consensus about exactly how much protein people should eat for optimal health and whether those who consume adequate calories should pay any special attention to their protein intake.[6] Even the seemingly indisputable claim that protein constitutes a crucial component of the human diet gives us pause, given all it assumes about what this substance is and what it can do.

Toward some stable ground, it is more accurate to say the following: All animals, including humans, need nitrogen to make the proteins that perform multiple bodily functions. Nitrogen is important to underscore here. When used to refer to substances that humans ingest, "protein" is a proxy for the nitrogen content of food—nitrogen that is then used to make proteins once it enters the body. At a molecular level, amino acids are the primary vehicles through which we obtain nitrogen. This is why "protein" is also a proxy for amino acids, though amino acids are additionally composed of hydrogen, carbon, and oxygen. The number of nitrogen-containing, protein-building amino acids the body requires is usually identified as twenty. Some researchers,

however, put that figure at twenty-one, to account for an additional "nonstandard" amino acid, selenocysteine, discovered in the late twentieth century, or at twenty-two if they are including pyrrolysine, another rare amino acid identified in 2002. Of those proteinogenic amino acids, nine are categorized as indispensable, which means that they cannot be produced by the body and must be obtained exogenously, from food.

This is the point at which the possibility of making overarching claims about protein intake begins to fray. In the face of inconsistent, imprecise, and unreliable experimental techniques for measuring either protein metabolism or the protein content of particular foodstuffs, questions about the form in which people should obtain those indispensable acids, in what quantity, in relation to which health conditions or aspirations, in the context of which food systems, and at which point in their lifespan (or indeed their day), remain the subject of ongoing research and debate.[7] This contentiousness is not readily apparent outside the nutrition research world or fitness and diet circles, where discussions about the desired level of protein intake for optimal performance and weight loss are de rigueur, and strong and often divergent opinions abound. If you are not privy to such conversations and turn to the internet for information, your findings will depend on where you are located. If you're searching from Canada or the United States and you ask, "How much protein should I eat per day," your results will turn up the same piece of apparently uncomplicated advice repeated over pages of results: "0.8 grams of protein per kilogram of body weight." But if you are in the United Kingdom, where food consumption and availability patterns are similar to North America, you will be advised to consume 0.75 grams per kilogram. If you are in Japan, you will be advised to consume 1.08 grams per kilogram, and if you are in one of the many countries that use either World Health Organization or European Union guidelines, the amount sits at 0.83 grams per kilogram. These differences are small but significant, reflecting not just contextual variables related to food availability and culinary cultures but also epistemological uncertainties and political contestations.

In the United States and Canada, the recommended daily allowance (RDA) of 0.8 grams of protein per kilogram of body weight is derived from the Dietary Reference Intakes (DRIS), a set of nutrient reference values released in 2002 by an expert panel appointed by the US National Academy of Medicine.[8] Used by policymakers, healthcare providers, and the food industry to plan and assess diets for healthy individuals and populations, the DRIS are powerful tools for the dissemination of nutritional norms and the determi-

nation of what people eat. They underpin the *Dietary Guidelines for Americans* and *Canada's Food Guide*, they form the basis for food assistance and school lunch programs, they constitute the standard against which the world's 250 million subscribers to *MyFitnessPal* can track their daily nutrient intake, and they are used by food and supplement manufacturers seeking to market their products. But if one actually ventures to open the document, any sense that the DRIs for protein are straightforward quickly evaporates. Spanning 179 pages, the "Protein and Amino Acids" section of the DRI report is highly elaborate and endlessly complex.[9] It is evident that the DRIs emerge from reproducible empirical data on the protein needs of humans—they are not without foundation, in other words, or contested to the point of meaninglessness. But the report is honest about the limits of contemporary nutritional knowledge, noting at the outset that "proteins in both the diet and body are more complex and variable than the other energy sources, carbohydrates and fats."[10] Thus, even in the realm of official dietary guidelines, where specifications are set by expert committees after years of deliberation, recommendations about protein consumption are tentative.[11] They are also subject to ongoing pressure from interested parties such as agribusiness, industry-sponsored researchers, and health evangelists of various stripes who would like to see them shift in one direction or another.[12]

Beyond the consensus statements that underpin dietary guidelines, what agreement there is about protein intake converges around the fact that protein deficiency is extremely rare in the absence of severe hunger and almost nonexistent among the consuming classes at the center of the protein boom.[13] Garth Davis, a bariatric surgeon and coauthor of the diet exposé *Proteinaholic*, conveys this point with a scenario featuring a five-foot-ten man weighing 160 pounds.[14] If all this man ate at each of his three daily meals was thirty Lay's potato chips and two slices of Domino's plain pizza, Davis contends, he would be consuming 1.6 more grams of protein than his daily recommended allowance. While the precise level at which daily protein intake should be fixed remains unsettled, the larger point stands: Protein is in practically everything people consume, from lettuce to potatoes, and if they have enough food to eat, they must go to extreme lengths to become protein deficient. It thus strikes us as more than curious that those people who appear to be most fixated on their protein intake are those who have the least to be concerned about. How and why, then, has protein emerged as an über-nutrient in the satiated world? To what ends? And at what costs?

Situating the Protein Boom

One way to understand contemporary protein mania is in relation to the broader rise of what critics call "nutritionism."[15] This is the ideological process through which the value of food is reduced to its biochemical components and measured according to Eurocentric, scientized standards rather than taste and experience. Growing out of a complex assemblage of forces, including the profit imperatives of global agribusiness and the responsibilizing imperatives of state-sponsored dietary guidelines, the hegemony of nutritionist thinking is undoubtedly at work in the extraction and isolation of protein from its nutritional and social context and the reduction of its value to that which can be assessed and measured as the central part of any meal.[16] Nutritionist logic thus oversimplifies the role of individual nutrients both in the pursuit of bodily health and in the solutions to the systemic problems (e.g., social inequality) in which nutrients are or appear to be implicated—a recurring issue in the story of protein, as we shall see.

Thinking about the broader social and historical conditions in which nutritionism has taken hold leads to another—complementary—way we might explain protein's allure, which is through the lens of what sociologist Nikolas Rose calls the age of "molecular biopolitics."[17] Rose argues that during the mid-twentieth century, scientific understandings of life and the biological body were "molecularized," which is to say that the body was reconceptualized at submicroscopic, subcellular levels and thus became knowable at a completely different scale than in previous eras of scientific investigation. Compare, for example, long-standing knowledge about muscles and their anatomical function in moving and powering the body to contemporary knowledge about amino acid chains and their genetic functions in the creation of muscle tissue, a process that is discernible only at the molecular level. Rose's claim is not simply about the scientific and technological developments that make this knowledge possible but also about their economic and social reach, not least the circuits of capital that are allied to new modes of knowing bodies beneath the skin.[18] His argument suggests that in the molecular age, optimizing our genetic, hormonal, and neurological selves in ways that mitigate individual risk and maximize the potential for flourishing and longevity has become possible, at least for those with access to this knowledge and the means to act on it. Health in these formulations is not just a matter of population governance or disease prevention but of personal actualization at the molecular scale, often cast in the language of the molecular sciences. Consider how particular amino acids are now paired to particular health, fitness,

and aesthetic goals, enabling consumers to pursue precise, targeted, "optimal" nutrition—L-serine for brain health, leucine for muscle mass, collagen peptides for hair, skin, and nails, and so on. The sheer possibility of referring to a nutrient as a superstar, granting it a cultural appeal, and incorporating it into the ways people understand their own bodies and relationships to food, owes a great deal to these shifts in scientific knowledge and the senses of selfhood they have enabled.

These are frameworks to which we return in the analysis that follows, but neither nutritionism and the emergence of the "nutricentric subject," nor molecular biopolitics and the emergence of the "neurochemical self," shed light on the specificity of protein primacy in contemporary dietary culture.[19] Why is protein, rather than fat, carbohydrate, vitamin D, or any number of other nutritional categories, so fetishized in the present moment? Why is *this* molecular matter the resounding staple of dietary regimens that have varying, and at times competing, objectives?

In response to these questions, we propose an additional context that helps explain the protein boom, one which is likely familiar to those already curious about or invested in protein's ubiquity. Since the 1980s, numerous studies have explored what historian Jürgen Martschukat calls the "age of fitness" in Western societies.[20] The popularity of practices such as running, yoga, and weightlifting, and the growth of associated industries, is the most obvious expression of the explosion of interest in the pursuit of a fit, healthy body that marks the last half century.[21] As for what animates this investment, scholars of physical activity have identified a litany of factors, from raced, classed, and gendered expectations of body shape and size, to antifatness stoked by obesity research and policy, to the sedentary nature of postindustrial societies, to a growing evidence base for the psychosocial benefits of physical activity.[22] Most critically attuned researchers home in on neoliberalism, however, as the overarching political and economic condition of possibility for the emergence of the fitness boom.[23] The affinities between fitness and neoliberalism are certainly compelling, given the latter's emphasis on individual responsibility for health and the former's role in helping to instantiate and legitimize the commonsense notion that individuals are in control of their corporeal destinies.[24] Fitness as a bodily practice and neoliberalism as a mode of governance also share a declared aversion to unproductive excess—be it fat or fiscal "inefficiencies" associated with redistributive state spending that benefits collective well-being. Both also ascribe a moral quality to entrepreneurial activity that bears evidence of discipline, effort, and self-control. In this confluence, neoliberalism begets and explains the valorization of fitness

in contemporary societies and, in particular, an aesthetics of bodily productivity that protein supplementation is believed to facilitate. If we accept the "age of fitness" as the embodied cultural expression of neoliberalism, then we might posit protein, with its flexible capacities and transformative promises, as an ideal vehicle for nourishing fitness regimes. It is not difficult to see how protein-enriched bodies forged through physical activity can connote value and (self-)worth in cultures saturated with neoliberal values, especially when allied to the prevalence of discourses of nutritionism and molecular selfhood.

The reach of neoliberal norms is such that fitness imperatives affect all of us, including those who don't work out. As physical activity consciousness, practices, spaces, knowledges, technologies, fashions, media, and diets infiltrate more and more of daily existence, weighing even on those who do not engage in instrumentalist exercise, so too does the multibillion-dollar market for protein supplements and fortified foods. Indeed, if the growth of fitness now amounts to what we might conceptualize as the athleticization of culture, then we wager that the athleticization of food culture, and especially the proteinization of food culture, have been major ingredients in this shift. It is not just that once-niche foodstuffs ingested by serious bodybuilders have entered the mainstream fitness world—a point we elaborate in chapter 5. Rather, specialized and highly technical approaches to diet that were once followed only by elite athletes seeking fractional improvements in performance have spread far beyond the world of fitness, thus revealing fitness as a primary vehicle for the spread of nutritionism, molecularization, and neoliberalism—all key factors in protein's rise.

These insights notwithstanding, it is worth emphasizing again—and not for the last time—that protein and its popularity resist and exceed attempts at neat and tidy explanations. In this instance, temporality emerges as an issue, since the protein boom is not distinctive to neoliberalism, and the present era is not the first to witness a fitness boom.[25] While protein's contemporary status is unprecedented in market terms—the protein powder market alone is estimated at US$21.6 billion[26]—protein has been enlisted in economic and political projects since its establishment as a nutritional category in mid-nineteenth-century Europe, and in numerous agro-technological, financial, and biopolitical ventures in the ensuing two centuries. The point here is that the obsession with protein has roots in global expansionist processes and projects that complicate any attribution to a single social formation or historical conjuncture. The last two chapters of the book explore the present political moment as indicative of this historical contingency and complexity: As neoliberal orthodoxy flounders and protofascist populist movements

gain strength all over the world, including in the United States, where a new age of "muscular capitalism" has taken hold, many online outlets for vindictive grievance politics and sovereign self-making projects are fueled by the supplement industry—a context we label "the muscular manosphere."[27] What is extraordinary about protein is not just that it plays an outsize role in powering this noxious brand of muscular capitalism in the digital networks in which it has flourished, but also that it has assumed this role before in quite different geopolitical and sociocultural contexts, as we chronicle in the chapters to follow. What kind of substance can withstand this turbulence, let alone thrive in it?

The need to think carefully about protein's remarkable staying power was underscored to us when the story of the protein boom entered a new chapter in the twenty-first century, one marked by an explosion of interest in plant-based and cellular meats. In response to escalating concern about the climate emergency, unstable supply chains, waning food security, and human and animal well-being, meat analogues are being pursued and touted as healthy, humane, and sustainable alternatives to large-scale livestock farming.[28] Scholars from many disciplinary vantages are asking critical questions about these developments and the multitude of possibilities and problems they raise.[29] Their many lines of inquiry relevant to our interests include the economic, political, and social forces driving—and obstructing—a protein transition, and the diffuse and uneven developmental pathways of alternative protein technologies, which range from niche innovations in cellular agriculture to the refinement of long-standing legume- and wheat-based alternatives produced by conventional food and commodity processing conglomerates as well as smaller corporate actors.[30] Other relevant studies explore the increasing concentration of power in capitalist agribusiness under the banner of "protein";[31] the construction of metaphors and "promissory narratives and future imaginaries" about alternative protein technologies among the biotech start-ups leading the development of cellular agriculture;[32] the importance of patentability and the reframing of "food as software" in the high-tech alternative protein sector;[33] the contested discursive terrain around the safety, feasibility, and sustainability of novel foods;[34] the ontological status of fake meat and dairy and their entanglements with animal agriculture;[35] the moral, affective, and aesthetic considerations raised by cellular agriculture;[36] and the environmental and health consequences of a shift to novel protein production and consumption.[37]

As we were finishing the book, new research on shifting expectations about the potential of alternative protein development to challenge food

system orthodoxies was appearing.[38] Public prospects have been tempered somewhat since 2022, when the market for the new generation of plant-based meats such as the Beyond Burger and the Impossible Sausage turned out to be more constrained than their promoters and investors initially hoped.[39] The collapse of their share price, and their removal from the menus of some of the big fast-food chains was followed, in 2023, by the closure of New Age Eats, a cultivated meat start-up that shuttered its doors having failed to attract the necessary funding to support ongoing infrastructure development.[40] Academics and journalists who are tracking the trajectories of alternative proteins point to a range of reasons for these challenges and flops. They usually land on some combination of fiscal, logistical, sensorial, and health drivers not helped by a meat industry–backed campaign that depicted burger and sausage analogues as packed with hidden additives and therefore less healthy than beef or pork—a move to which we return in the epilogue. Critic Julie Guthman is particularly uncompromising in her assessment of what she depicts as ill-informed and ineffective tech solutions that fail to address the root causes of a broken food system.[41] Silicon Valley is Guthman's focus, though this is only one locus of development in alternative proteins, and recent upheaval in the United States constitutes only one chapter in a story that continues to unfold along multiple pathways, including in the United Kingdom and Germany, where governments are starting to invest in a sector that has until recently been funded largely by private money.[42] At the same time, some protein start-ups and innovators have thrown their lot in with the same corporations charged with promulgating the harms of industrial animal agriculture, given the presumed capacity of these firms to scale up production and infrastructure.[43]

From our vantage point, what is striking about all this activity is that protein's rise as the dietary elixir par excellence and its status as a nutritional superstar remain largely unquestioned, even by those seeking systemic transformation.[44] As entrepreneurs and scientists attempt to engineer a future in which food is cleansed of its associations with the harms of industrial animal agriculture, and critical scholarship appraises their claims, the anchoring category of their engagement gets naturalized and secured. Whereas anxiety about the sustainability of the food system and efforts to transform it have forced a deep reckoning with the meanings and materialities of meat and dairy, the same cannot be said of protein, which emerges as an escape valve of sorts for a range of actors seeking to rethink and rebrand animal sustenance. In these conversations, protein tends to hover hazily in the background, its

capacity to attract an ongoing supply of attention and investment, on the one hand, belying its elusive and abstract character, on the other.

Materialisms Old and New: Theorizing Protein's Capacities

To grasp the significance of protein's hold on the nutritional imagination requires figuring its contemporary status as more than the conceit of empire-building nutritional science, more than another example of nutritionist reductivism or molecular embodiment, and more than the sculpted silhouette of neoliberal capitalist hegemony reflected against the gymnasium wall. The manufacture of cellular and plant-based proteins orients attention to the *active* material capacities of the substances gathered under this category, the vital force with which protein is synonymous, alongside the problems of the global food system and the ecological breakdown to which entrepreneurs are responding. The interest in novel proteins also draws attention to the multiplicity of meanings adhered to protein and the benefits it is intended to generate, as well as the history of protein's uptake over the *longue durée* of its biography. What's required is an approach that brings together protein's socio-ecological history, constitution, and potential, one that attends to its material manifestations in order to explain its historical emergence as a coherent and lauded category.

Our approach and arguments in this book come through engagements with a host of scholarly fields that take seriously relations among power, nature, and history. Political ecology, science studies, food studies, sport studies, and body studies have been especially key in lending insights about how the vital capacities of biochemicals are connected to environmental concerns, how metabolic processes are implicated in food politics and vice versa, how knowledge about diet is constructed and interpreted, and how economic and social concerns cohere in embodied practices. Two schools of materialist philosophy that respectively emphasize the force of world-historical processes in shaping social relations, and the force of material life to act and make a difference in those relations, have been especially important. To unravel their explanatory power and their theoretical continuities and tensions, let us foreground the form in which protein's allure first made itself known to us.

One of protein's primary manifestations in the contemporary world is as a nutritional supplement, an object for consumption in health and fitness cultures. When we call protein an elixir, we conjure its quasi-magical associations with good health, even as we argue that protein is much more than any

single ascription can hold. Indeed, one of its tendencies is to exceed categorization and veer outside the crosshairs of analysis. But we have to start somewhere, and protein as a valuable commodity in the nutrition supplement market is the form with which many readers of this book will already be acquainted and the form that primarily occupies us in the chapters that follow.

Studying protein through a materialist lens means recognizing that when a gym-goer, dietary enthusiast, or unsuspecting consumer ingests proteinous foodstuff, that abstracted matter *comes from somewhere*, and the transitory moment of consumption connects them to a dense web of lives and forces beyond their actions and milieus. This is the same logic that Karl Marx deployed in his decision to lead with the proliferation of commodities in *Capital*, and although his work derives from another century, it is a mode of materialist thought that continues to inform critical accounts of social and cultural life.[45] Marx was writing through the upheavals of industrializing societies in mid-nineteenth-century Europe, where the scale and type of production was transforming landscapes, livelihoods, and labor all around him. Observing capitalism's alchemic transformations of earthly matter into commodities, Marx set about tracking those transformations into discernible social relations so as to demystify the workings of capital. There are many specific philosophical and economic debates to be had about this method, but for us it is the general approach to situating commodities that has proved most instructive. For example, in chapter 1 this mode of analysis helps us discern how protein's invention as a singular nutrient by a vanguard of nineteenth-century European biochemists was, from the outset, a process of commodification, one tethered to the expansionist imperatives of capitalist and colonial world-making that has now reached an apotheosis in the circulation of protein in global food markets. That chapter tells the story of how renowned biochemist Justus von Liebig—whose research on soil was a significant influence on Marx's own thought[46]—held together the ontological question about what exactly protein is with the entrepreneurial matter of its deployment as a necessary supplement in domestic and international markets. Here, we work in a similar way, reckoning with protein's biochemical and commodity forms in order to situate them within circuits of exchange and accumulation, chart the social conditions of their emergence and diffusions, and demystify the seemingly endless and often unmitigated stream of "protein hype."

This "older" materialist approach for following commodities and situating their circulation in world-historical processes imprints on the entirety of our analysis, as does the broader sensibility toward illuminating how systemic forces have animated protein in the pursuit of power and profit. They aid

us in "following" our subject on its travels through laboratories and public health campaigns, sewers and pharmaceuticals, gyms and digital networks, and the bodies of flesh, land, and water that protein, in turn, reshapes along the way. In this sense, our work resonates with kindred literature on the pursuit of "things" through different spaces, divisions of labor, social relations, more-than-human actor entanglements, and other material-discursive webs.[47] Arjun Appadurai's insight that "all things are congealed moments in a longer social trajectory" has proven especially useful when infused with a method that opens up the social to include the ecological, multispecies trajectories along which protein travels.[48]

No doubt owing something to these analytical tools, our early attempts to follow protein and to pin down its composition and impacts engendered several scoops of skepticism about its transformative properties. Yet the more we learned of protein's indeterminacy and evasiveness, even in the face of commodification, the more we recognized the need to take these qualities seriously. After all, proteins are many things, from molecules to meal staples and much more besides. They are in us and around us; they move between us, act on us, and operate beyond us. Protein can take the form of viral "spikes" that penetrate cells with dangerous consequences for human health or of granular powder mundanely consumed after a morning run. Any attempt to make scientific, health, or commercial claims about protein thus requires a great deal of boundary work just to delimit what "it" is in that instance, let alone its effects in any given context.

As we followed protein on its circuitous travels through markets, cultures, and bodies, the significance of its dexterity and transformative capacity gradually began to emerge less as a paradox than as a potential explanation. Might it be that this elusive, indeterminate quality is no mere glitch in knowledge about protein but could actually be central to its power? This proposition about protein's capacities aligns with what is often described as a "new" mode of materialist thought—a distinct collection of philosophies and research practices that have become influential in the last two decades or so. New materialist approaches (alongside related approaches such as posthumanism, actor-network theory, and speculative and agential realism) seek to theorize the agency and sociality not just of humans but of plants, animals, chemicals, machines, and other entities whose vitality and affective capacities, it is often implied, have hitherto been neglected.[49] In some cases, such recognition is mobilized to theorize the human condition at a moment of profound and ruinous ecological transformation known widely as the Anthropocene.[50] Recognizing the agentic capacities of material life serves as a

corrective to the idea of both agency as a primarily human capacity and the Anthropocene as an epoch in which human activity is equated to the "great forces of nature" in its reach and effects.[51] This may constitute the unifying political intervention of the "new" materialisms. Their influence is seen in an outpouring of concepts that extend the boundaries of human subjecthood, afford agency to nonhuman phenomena, and aim to attune readers to a shared planetary existence of multispecies, multiorganismic relationality.

Debates continue to rage about both the newness of this version of materialism and the appropriateness of the Anthropocene as an epochal denominator of our socio-ecological present.[52] In sweeping terms, we might say that "old" materialist perspectives emphasize the force of history and hierarchical systems of power, whereas "new" materialist perspectives emphasize the agency of matter and nature in constituting social and ecological life. In practice, these approaches traverse such binary framings, but the extent to which scholars integrate these considerations varies greatly, and there has been significant discord between their more ardent adherents. This conflict reflects long-standing questions about the philosophical premises of Marx's historical materialism and its contemporary relevance, on the one hand, and a suspicion that the "new" materialisms fail to adequately reckon with the histories of race, capital, and empire that have shaped so much of the modern world, on the other.[53] Whereas the newer schools stress the distributed agency of forces involved in climatic upheaval, in part to temper fantasies of mastery over nature that still undergird some Anthropocene theorizing, their critics point out that such assessments often underplay the human, social dynamics of climate transformation, and the fact that climate change is neither waged nor experienced uniformly by all groups of people. Similarly, some hold that the Anthropocene demands fresher modes of understanding the world than are offered by the established conceptual repertoires of the interpretive social sciences and humanities.[54] Others, meanwhile, see as obvious the need to incorporate several centuries of knowledge into contemporary approaches and argue that the fetishization of the "new" risks neglecting the ongoing violence inflicted by capitalism and colonialism as the world heats up.[55]

Allied with traditions of thought that have never imagined human corporeality outside of nature, our approach in this book stems from a conviction that understanding the vital capacities of protein need not detract or distract from its implication in world-historical processes.[56] On the contrary, one of our central contentions is that protein's elusive, dynamic character is the key to its social power. Far from being incidental to its hallowed status and cultural prevalence, protein's vital capacities and opaqueness are what

make it amenable to biopolitical, economic, and environmental imperatives. In alignment with scholars who conceptualize agentic matter not beyond but *as* power and history, this claim strikes a dialogue with "new" materialist and related approaches that explore how lively, multispecies, multiorganismic relationships constitute "human" life, while retaining an emphasis on the social forces that shape and mediate protein biologies, with far-reaching and disparate effects.[57] From this vantage point, we explore how protein has been put forward as the magical solution to a diverse range of problems: from malnutrition in the Global South in the form of culturally alien techno-foods, to pollution in industrial farming in the form of regenerated whey waste, to muscle loss in seniors in the form of drugs and other prescriptions designed to increase protein synthesis, to the "crisis" of contemporary white manhood in the form of bodybuilding supplements, and to the climate emergency itself in the form of "green" or "alternative" protein. We situate each of these innovations in their historical and socio-ecological contexts, highlighting colonial superiority, capitalist ingenuity, age-as-deficit, white Trumpian masculinity, and ecomodernism as key to understanding protein's attractiveness as a multipurpose fix for all manner of ills, real and imagined.

The need to think of protein not only as a substance embroiled in hierarchical and often violent processes of commodification but also as an agentic, socio-ecological phenomenon did not arise from philosophy alone. It came through our exploration of the creation of whey powder, initially familiar to us and likely to many readers as the most popular protein supplement. In seeking to chart whey's commodification and appeal, we discovered that it has a curious double life, acting not only as a health elixir but also as a noxious by-product of the dairy industry.[58] The transformation of whey into a palatable, proteinous foodstuff has been triumphantly touted as a green solution to the intractable problem of toxic whey waste. While that waste is itself an outcome of dairy overproduction, it gets reframed in this story as an opportunity for the exercise of technoscientific ingenuity and capitalist innovation—its transformation into a profitable commodity demonstrating the possibility of making a market out of anything. On closer inspection, though, we found that the nitrogenous quality that allows whey to materialize as both panacea and poison does not disappear through mass production or even upon digestion. Rather than being purified through its commodification and then disappearing after ingestion, whey reemerges in other guises once it has passed through the bodies of the humans who consume it. In other words, whey's dense capacities present challenges to the global nitrogen cycle not just at the point of production, where whey powder is posited

as a solution, but to the lands and waters it moves through after consumption and excretion.

Figuring protein as a socio-ecological phenomenon might appear paradoxical given that proteins are conventionally understood as fundamentally biological and that human biology is typically understood as unfolding largely "inside" the body. But the lessons we gleaned from pursuing these dynamic molecules on their travels through a plethora of bodies and substances dispelled any pretensions to this duality. We traced whey's movements from cows and their milk into supplements and additives, and on into humans and other animals who consume whey as part of their diet. Given that whey waste is only ever partially recaptured and purified, we were also led from dairy wastewater into lakes, rivers, and oceans, where it spurs plant growth and denies fish and other aquatic creatures the oxygen they need to survive. As a result, we were impelled to understand how whey exceeds the boundaries of the body and the environment, the ecological and the social, the healthy and the hazardous. The same, we later realized, was true of protein writ large: If we wanted to understand where the protein people consume comes from, where it goes once their bodies have processed it, and how its vital capacities make a difference in the world, we would need to consider protein in its diverse manifestations, from the cellular to the social.[59]

Protein emerges from this analysis not as a purely biological substance, a neutral nutritional category, or a singular cultural artifact but as a powerful, shapeshifting, socio-natural agent enlisted in diffuse webs of political, economic, and ecological forces. This is a conceptualization that denaturalizes the category of protein and destabilizes its axiomatic associations with health and nutritional value while accounting for the difference that protein's lively attributes, affective propensities, and relational qualities make in the world. It is an orientation that takes seriously protein's materiality, not as part of a philosophical exercise to determine its thingness, or a biochemical exercise to explain its role among the "building blocks of life," but in order to understand how its vital properties (i.e., what makes it both nutritionally valuable and environmentally problematic) are mobilized within iniquitous entanglements. It is a way of knowing protein as a substance that is easily adhered to diverse corporeal, economic, and political ends precisely because of its extraordinary dexterity, and it is an approach that keeps in view our subject's capacity for comprising, sustaining, and fortifying biological life while recognizing that little about protein is stable, self-evident, or neutral, whatever shape it takes.

In keeping with this emphasis on relationality and materiality, it bears emphasizing that protein's capacities are neither exercised autonomously nor

simply willed into being by the might of protein hype or the powerful imperatives that propel protein markets. The active body, the labor it exerts, and the biophysical processes that follow are vital to materializing protein's capacities. This is something that all protein enthusiasts know, yet it is easily overlooked. In order to have a chance of realizing the promises with which it is endowed, in order to process its nitrogenous potential and transform it from food into muscle, protein requires sufficient physical and metabolic work. Put differently, protein's continued appeal rests on the specter of its absence and the desires, anxieties, and persistence of fitness enthusiasts and others subject to its allure. Without a preoccupation with muscle mass and strength, and with weight loss and gain, the labor required to unlock protein's capacities would occur only incidentally and certainly not in a way that would support the booming transnational market in protein products we see today. In other words, the hype surrounding the protein boom is hollow without multifarious forms of physical and affective labor and a populace willing and able to bring about those metabolic transformations. A socio-ecological approach to protein engenders a sensitivity to the biosocial labor of bodily metabolism in its relations with wider metabolic changes—that is, the exchange of matter among human society and nature that Marx called "social metabolism." We discuss these changes further in chapter 3, which explores the making of the protein powder industry. For now, suffice it to say that the bodily labor required to metabolize protein, and the work required to mass produce it, can be thought together when protein is understood as socio-ecological "all the way down."

Bringing these insights together, we can offer some conceptual dimensions of protein that depart from the reductive or decontextualized notions we have highlighted en route. We contend that protein is best understood as an elusive, dynamic, contingent, multiplicitous force: *elusive* because two centuries of proliferating investigation has repeatedly found protein to evade simple definition or categorization; *dynamic* because the agency of protein, its capacity to act and make a difference within bodies and wherever bodies and environments commingle, is increasingly recognized by biochemists, molecular biologists, ecologists, and social scientists alike, albeit with differing emphases and conclusions; *contingent* because claims about what protein is or does come with caveats about the involvement of other chemical bodies, or scientific apparatus, or the labor of humans (or animals), without which protein would not materialize as expected or "swerve" off course in ways that confound its followers and adherents; and *multiplicitous* because the forms it takes as muscle, food, waste, molecules, chemicals, and more must be understood

not as entirely distinct or homogeneous but, in Annemarie Mol's terms, as versions of a phenomenon manifesting differently, those differences owing to a combination of its elusiveness, dynamism, and contingency.[60]

To these dimensions, we can add another, one that encapsulates our arguments about protein's social power. Protein is *adhesive* in that it can be (and has been) attached to an eclectic range of biopolitical imperatives, commercial ventures, and health and fitness goals, from global problems of population hunger and the climate crisis to everyday matters of meal preparation. Often its invocation is as a solution to or intervention in these outcomes, while at other times it serves as an underpinning rationale for social and political action, a unifying nutrient beyond reproach. Crucially, it is protein's capacities and tendencies that make its adherence to these problems and projects potent and enduring. In other words, were protein knowledge absolute, were its secrets revealed as a matter of record for all to survey, then its influence and status would surely diminish. As it stands, protein's power lies in its potential, an ambiguous glow of possibilities that stem from the elusiveness, dynamism, contingency, and multiplicity through which it is adhered to all manner of desires, bodies, and worlds.

Following Protein: Overview and Chapter Outline

To state plainly what is likely obvious by this point: Protein can be hard to pin down. We have pursued our subject for years now, like paparazzi in search of the next exclusive shot, of a unique glimpse into the life of a celebrity who is both familiar and elusive, everywhere and nowhere. Sometimes we'd get close, only for protein to change appearances, to transform into something else as it moved from one disciplinary domain, social location, or biological entity to another. Conventionally, the biochemists, biologists, agricultural and environmental scientists, nutritionists, exercise physiologists, and others who work on protein do so in silos, often operating with differing definitions of what it is, what it does, and what problems, if any, it presents. In the meantime, with a few notable exceptions, social scientists are absent from the conversation.[61] This book addresses this fragmentation by following its subject across disciplinary lines, paying particular attention to the generation and contestation of protein knowledge and the propensity of this disorderly biological agent to challenge established insights and refuse attempts to tame its capacities.[62] Where it has proven necessary to isolate or contain protein in a particular place, scene, or time, we have sought to retain a conceptualization of this complex substance as a "contentious synthesis" of humans and

nonhumans, of "bodies becoming other bodies," and thus, in Eric Sarmiento's words, as a point of departure for questions of "embodiment, relationality, power, and collective becomings."[63] This approach highlights how human bodies are unevenly incorporated into commodity relations as producers and consumers of protein, highlighting the racial and colonial infrastructures that undergird protein booms past and present.

Through these theoretical and methodological considerations, we arrive at the overarching contention that protein's status as a nutritional superstar—its unimpeachable character—has little to do with most people's actual dietary needs. The science of protein intake is evolving and contested, and while other scholars seek greater certainty about protein's essence and function through the production of ever more precise forms of knowledge, we suggest that only a conjunctural analysis, one that takes seriously the multiple socio-ecological histories that have produced protein as a coherent category and valuable commodity, can adequately explain its enduring cultural significance. The tendency to take for granted protein's ontological complexity and to naturalize its premium status can be found even among the growing community of scholars producing critical work on protein, where the "why protein, why now" question is rarely broached. Seeking to join this conversation, we offer a story that holds together protein's vitality, its imbrication in relations of power, and its cultural appeal, historically and in the present. In attending to the consequences of protein primacy, we reveal how the strengthening of some bodies through protein-enriched diets occurs at the expense of others. Our argument emphasizes that the cultural preoccupation with protein is not innocent, in other words, and that its effects are felt because of—not despite—its elusive, dynamic, contingent, multiplicitous, and adhesive propensities.

The chapters that follow each offer historically situated accounts of specific moments, sites, and spaces in which attempts have been made to harness protein's meanings and material forms. As readers will see, these moments coincide with different phases and dimensions of capitalism—contingencies that we highlight as our analysis proceeds. We begin with the emergence of protein as a nutritional category and with our realization that debates about what protein is, and what the term *protein* should rightfully designate, are as long-standing as modern science itself. These debates form the focus of chapter 1, "What Is Protein and Why Does It Matter? Mystery and Magnetism from Molecules to Meat." German scientist and entrepreneur Justus von Liebig plays a prominent role in this narrative. We show how his 1842 proclamation of protein as the only "true" nutrient and meat as the optimal source

of protein was crucial to securing protein's cultural ascendence, its insertion into frameworks of racial superiority, and its attachment to capitalist projects that include the making of a global food market. While Liebig helped establish protein's enduring valence, his findings were contested at every stage. As we trace these contestations, we show how this epistemological uncertainty has persisted into the twenty-first century and situate our work in relation to that of other social scientists who have written about the elusive and wily nature of proteins. Whereas that scholarship tends to focus on protein's biography as it unfolds in the research lab, we trace its manifestations and travels across broader disciplinary and social domains, establishing what can be learned by following protein through the multiple and diffuse political projects to which it has been made to adhere.[64]

In chapter 2, "The Great Protein Fiasco, Then and Now: Nutrition, Development, and the Trouble with Growth," we revisit one of nutrition history's most prominent conflicts. During the 1950s and 1960s, considerable scholarly and economic resources were invested in the subsequently disproven idea that there existed a deep and deadly "protein gap" between the world's rich and poor. Our analysis centers the ways that racial and colonial thinking about ideal corporeal growth and size, in concert with discourses of development and imperatives to address Western agricultural overproduction, helped propel the idea of a global protein crisis. We situate our analysis in the *longue durée* of protein history, arguing that the temporal and spatial persistence of protein fetishization linked to the growth of bodies, economies, and empires brings into question the limited scope connoted by understanding this period as a "fiasco." Our argument is not that protein deficiency or unequal access to it was (or is) a fiction. Rather, we contend that protein supplementation was mobilized as a universal, market-friendly, technocratic solution to a set of colonial social, agricultural, and labor conditions that were driving malnourishment. This is the story not of a mistake, in other words, but of a shape-shifting continuity by which protein knowledges help reproduce globally stratified and physically embodied dichotomies between healthy and unhealthy bodies, in concert with responsibilizing discourses of lifestyle and development.

In chapter 3, "From Gutter to Gold: A Political Ecology of the Protein Powder Industry," we start to provide answers to the question of what protein does by focusing on the development of the most popular protein supplement and additive: whey. Our analysis is set in mid-twentieth-century Canada and the United States, where the rapid industrialization of dairy agriculture and its ecological fallout played leading roles in the commodification of whey effluent. In the official storyline attached to whey's twentieth-century transformation,

capital investment and technoscientific ingenuity responded as one to an environmental problem—the massive quantities of toxic whey effluent generated by intensive dairy production—and produced not only a solution but also a multibillion-dollar protein powder market. Our version of whey's biography diverges from this triumphant tale. In exploring the transmogrification of whey from a noxious by-product of dairy overproduction to a nutritional commodity deemed essential to many diet and fitness regimens, we find a multiplicitous substance with no simple line of ascendance but instead a messy ancestry of techno-innovations, capitalist imperatives, dairy cow exploitation, environmental campaigning, and a biopolitical shift toward the optimization of bodily health. Following whey powder through its historical emergence and into the formation of a protein powder market, we show how protein travels and mutates through and with bodies and machines in a dance of dispersion and assemblage that creates surpluses of value and waste, strengthening some bodies and compromising others. In so doing, we consider how protein resists and refuses attempts to harness its vitality for all sorts of ends. Whey powder—itself a technoscientific outcome born of attempts to manage the unruly and environmentally destructive proteins constitutive of whey waste—thereby represents a key site through which to assess the epistemological and political implications of protein's agentic capacities.

Having established whey powder as a primary vehicle for facilitating the mass production and diffusion of protein supplementation, we shift our focus to spaces of protein marketing and consumption. In chapter 4, "A Poverty of Flesh? Sarcopenia, Aging, and the Economization of Protein Deficiency," we trace the development of sarcopenia (loss of skeletal muscle mass and strength) as a category of disease that positions all humans as either currently or potentially deficient in protein. By situating leading research on sarcopenia in the conjunctural conditions of its emergence in the late 1980s, we show how sarcopenia became constituted as a disease of protein deficiency at a particular historical moment, one in which the need to find homes for nutritional sources of protein, the defunding of healthcare for aging populations, the frontier-building demands of the neoliberal university, and the ascendance of protein's status among nutricentric subjects coalesce. Through sarcopenia, protein deficiency is established as an inevitable reality of advancing years on earth, with consequences for how those years are experienced. But it also becomes a pliable, reversible phenomenon, something inexorable unless one undertakes certain practices of the body to mitigate its effects.

In chapter 5, "Protein in the Muscular Manosphere: Supplementation, Self-Optimization, and Microfascism in Men's Fitness Culture," we pursue

amino acid supplementation into perhaps the most obvious site for analysis in a book about protein. Our focus is on what we call the "muscular manosphere"—a US-rooted, globally resonant, networked men's body culture where life optimization and self-ownership are fueled by protein powder and other lifestyle fixes for masculinities perceived as under threat and in need of revival. As we trace protein's commodified form through the lifestyle prescriptions and downline economy of some of the manosphere's most prominent entrepreneurs, we depart somewhat from the previous chapter. There we explored investment in the fit body as a quintessential manifestation of the self-responsible, productive, individuated, neoliberal subject. Here we propose a more complex relationship with neoliberalism's tenets, one that can emerge only as neoliberalism flounders. We argue that in the face of climate and labor precarity, existential insecurity, and a growing distrust of market forces, protein-fueled training of the body becomes a salve for a wounded Trumpian masculinity with links to a latent and emergent "microfascism" in which misogyny and whiteness are inherent to the absolute focus on bodily control and sovereign, optimized codes for living.

Our epilogue takes the long history of protein supplementation told in the previous chapters as a point of departure for confronting a number of key tensions in the present. The backdrop for our discussion is the place of protein in the contemporary culture wars, its adhesion to meat-first populism, and the existential threat that protein innovation is felt to pose. We offer reflections on how and why the protein supplementation market continues to expand even as the science underpinning it remains contested, even as its manifestations old and new are challenged by competing visions of climate and sustainability, and even as answers to the seemingly simple dietary questions "How much?" and "What kind?" become more desired and harder to find.

Notes

INTRODUCTION

1. See Twine, "Emissions from Animal Agriculture."

2. MacDonald, "Producing Protein," 32. See also Adjemian et al., "Protein Politics"; Howard et al., "'Protein' Industry Convergence"; Mylan, Andrews, and Maye, "The Big Business of Sustainable Food Production and Consumption."

3. Decker, "How to Compete in the Crowded Protein Market"; and see Guthman, "Binging and Purging."

4. Decker, "How to Compete in the Crowded Protein Market."

5. See Davis and Jacobson, *Proteinaholic*.

6. See Davis and Jacobson, *Proteinaholic*.

7. See Hayes, "Measuring Protein Content in Food"; Davis and Jacobson, *Proteinaholic*; Nishimura et al., "Dietary Protein Requirements and Recommendations for Healthy Older Adults"; and Heid, "The Great Protein Debate Heats Up."

8. Institute of Medicine, *Dietary Reference Intakes*.

9. Institute of Medicine, *Dietary Reference Intakes*.

10. Institute of Medicine, *Dietary Reference Intakes*, 590.

11. See Overend, *Shifting Food Facts*.

12. See Farrington, "Take It with a Grain (or More) of Salt."

13. See Berryman et al., "Protein Intake Trends and Conformity with the Dietary Reference Intakes in the United States."

14. Davis and Jacobson, *Proteinaholic*.

15. See Belasco, *Appetite for Change*; Pollan, *In Defense of Food*; and Scrinis, *Nutritionism*.

16. See Scrinis, *Nutritionism*.

17. Rose, *The Politics of Life Itself*, 11.

18. See Cooper, *Life as Surplus*.

19. Scrinis, *Nutritionism*; Rose, "Molecular Biopolitics."

20. Martschukat, *The Age of Fitness*.

21. See Ingham, "From Public Issue to Personal Trouble."

22. See Atkinson, "Playing with Fire"; Gard and Wright, *The Obesity Epidemic*; Dworkin and Wachs, *Body Panic*; Jeffords, *Hard Bodies*; and Toffoletti and Thorpe, "Bodies, Gender, and Digital Affect."

23. See Martschukat, *The Age of Fitness*; Howell and Ingham, "From Social Problem to Personal Issue"; Ingham, "From Public Issue to Personal Trouble"; and Cole and Hribar, "Celebrity Feminism."

24. See Howell and Ingham, "From Social Problem to Personal Issue"; and Ingham, "From Public Issue to Personal Trouble."

25. See Hargreaves and Vertinsky, *Physical Culture, Power and the Body*; and Millington, *Fitness, Technology and Society*.

26. Pulidindi and Ahuja, "Protein Powder Market Size by Source."

27. Seymour, *Disaster Nationalism*, 11.

28. See Intergovernmental Panel on Climate Change, *Climate Change and Land: An IPPC Special Report on Climate Change, Desertification, Land Degradation, Sustainable Land Management, Food Security, and Greenhouse Gas Fluxes in Terrestrial Ecosystems*, 2020, http://ipcc.ch.

29. For comprehensive reviews of this literature, see Lonkila and Kaljonen, "Promises of Meat and Milk Alternatives"; and Mylan, Andrews, and Maye, "The Big Business of Sustainable Food Production and Consumption."

30. Guthman and Biltekoff, "Magical Disruption?"; Mylan, Andrews, and Maye, "The Big Business of Sustainable Food Production and Consumption."

31. Howard et al., "'Protein' Industry Convergence."

32. Guthman and Biltekoff, "Magical Disruption?"; Broad, "Making Meat, Better"; Stephens, King, and Lyall, "Blood, Meat, and Upscaling Tissue Engineering."

33. Sexton, "Food as Software."

34. Chiles, "If They Come, We Will Build It"; Sexton, Garnett, and Lorimer, "Framing the Future of Food."

35. Jönsson, "Benevolent Technotopias"; Jönsson, Linné, and McCrow-Young, "Many Meats and Many Milks?"; Lonkila and Kaljonen, "Promises of Meat and Milk Alternatives"; Stephens et al., "Bringing Cultured Meat to Market."

36. Sexton, "Eating for the Post-Anthropocene"; Van der Weele and Driessen, "Emerging Profiles for Cultured Meat."

37. Lynch and Pierrehumbert, "Climate Impacts of Cultured Meat and Beef Cattle"; Santo et al., "Considering Plant-Based Meat Substitutes"; Verbeke, Sans, and Van Loo, "Challenges and Prospects for Consumer Acceptance of Cultured Meat."

38. Guthman and Fairbairn, "Speculating on Collapse."

39. Creswell, "Beyond Meat Is Struggling."

40. Guthman and Fairbairn, "Speculating on Collapse."

41. Guthman, *The Problems with Solutions*.

42. Good Food Institute, *State of Global Policy 2023: Public Investment in Alternative Proteins to Feed a Growing World*, accessed May 12, 2025, https://gfi.org/resource/alternative-proteins-state-of-global-policy/.

43. Howard et al., "'Protein' Industry Convergence"; Guthman and Fairbairn, "Speculating on Collapse."

44. Guthman and Biltekoff ask a version of this question in their article on alternative protein development in Silicon Valley: Guthman and Biltekoff, "Agri-Food Tech's Building Block."

45. Marx, *Capital*, vol. 1.

46. See Ware, "Robbing the Soil."

47. See Appadurai, "Introduction: Commodities and the Politics of Value"; Cook, "Follow the Thing: Papaya"; Latour, *Reassembling the Social*; Marx, *Capital*; and Mol, *The Body Multiple*.

48. Appadurai, "The Thing Itself," 15.

49. See Barad, *Meeting the Universe Halfway*; and Coole and Frost, *New Materialisms*.

50. See Steffen, Crutzen, and McNeill, "The Anthropocene."

51. See Steffen, Crutzen, and McNeill, "The Anthropocene."

52. See Ahmed, "Imaginary Prohibitions"; and Davis et al., "Anthropocene, Capitalocene, . . . Plantationocene?"

53. See King and Weedon, "The Nature of the Body"; Ahmed, "Imaginary Prohibitions"; Davis et al., "Anthropocene, Capitalocene, . . . Plantationocene?"; Karera, "Blackness and the Pitfalls of Anthropocene Ethics"; and Leong, "The Mattering of Black Lives."

54. See Chakrabarty, *The Climate of History in a Planetary Age*.

55. See Baldwin and Erickson, "Introduction: Whiteness, Coloniality, and the Anthropocene"; Vergès, "Racial Capitalocene"; and Yusoff, *A Billion Black Anthropocenes*.

56. See Ahuja, *Bioinsecurities*; Davis et al., "Anthropocene, Capitalocene, . . . Plantationocene?"; and TallBear, "An Indigenous Reflection."

57. See Ahuja, *Bioinsecurities*; Davis et al., "Anthropocene, Capitalocene, . . . Plantationocene?"; TallBear, "An Indigenous Reflection"; Haraway, *When Species Meet*; and Kirksey and Helmreich, "The Emergence of Multispecies Ethnography."

58. King and Weedon, "Embodiment Is Ecological."

59. King and Weedon, "Embodiment Is Ecological."

60. Mol, "Layers or Versions?"

61. See Frost, *Biocultural Creatures*; and Myers, *Rendering Life Molecular*.

62. Myers, *Rendering Life Molecular*.

63. Sarmiento, "Umwelt, Food, and the Limits of Control," 74.

64. See Frost, *Biocultural Creatures*; and Myers, *Rendering Life Molecular*.

CHAPTER ONE. WHAT IS PROTEIN AND WHY DOES IT MATTER?

1. Glas, "The Evolution of a Scientific Concept."

2. See Carpenter, *Protein and Energy*, 48; and Liebig, "Animal Chemistry," 103.

3. See Frost, *Biocultural Creatures*; Myers, *Rendering Life Molecular*.

4. Frost, *Biocultural Creatures*, 1.

5. Frost, *Biocultural Creatures*, 27.

6. Frost, *Biocultural Creatures*, 116.

7. Myers, *Rendering Life Molecular*.

8. Myers, *Rendering Life Molecular*, 6.

9. Frost, *Biocultural Creatures*, 78.

10. Myers, *Rendering Life Molecular*, 239.

11. Myers, *Rendering Life Molecular*, 239.

12. Myers, *Rendering Life Molecular*, x.