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This offering
for
our children
and
the practitioners of deep medicine,
past, present, and future

INTRODUCTION

> I am talking of millions of men who have been skillfully injected with fear, inferiority complexes, trepidation, servility, despair, abasement.
>
> —AIMÉ CÉSAIRE[1]

> The body is also directly involved in a political field; power relations have an immediate hold upon it; they invest it, mark it, train it, torture it, force it to carry out tasks, to perform ceremonies, to emit signs. This political investment of the body is bound up, in accordance with complex reciprocal relations, with its economic use; it is largely as a force of production that the body is invested with relations of power and domination; but, on the other hand, its constitution as labor power is possible only if it is caught up in a system of subjection (in which need is also a political instrument meticulously prepared, calculated and used); the body becomes a useful force only if it is both a productive body and a subjected body. This subjection is not only obtained by the instruments of violence or ideology; it can also be direct, physical, pitting force against force, bearing on material elements, and yet without involving violence; it may be calculated, organized, technically thought out; it may be subtle, make use neither of weapons nor of terror and yet remain of a physical order.
>
> —MICHEL FOUCAULT[2]

> She then told him: "The student has performed his austerities and faithfully tended the fires. Teach him before the fires beat you to it." But Satyakama went on a journey without ever teaching him.... The fires then said to each other: "The student has performed his austerities and faithfully tended us. So come, let us teach him."
>
> *—CHANDOGYA UPANISHAD*

AS THE WORLD BURNS

Your body is inflamed. If you haven't felt it yet, you or someone close to you soon will. Symptoms to look for include uncontrolled weight gain or unexpected weight loss, skin rashes, difficulty with memory, fever, trouble breathing, and chest pain. Inflammation accompanies almost every disease in the modern world: heart disease, cancer, inflammatory bowel disease, Alzheimer's, depression, obesity, diabetes, and more. The difference between a mild course and a fatal case of Covid-19 is the presence or absence of systemic inflammation.

Your body is part of a society inflamed. Covid has exposed the combustible injustices of systemic racism and global capitalism. Demagogues around the world kindle distrust and hatred. Governments send in the police to impose order, monitor lockdowns, enforce a return to work for those who comply and incarceration for those who do not.[3] From the United States to South Africa, India, Brazil, and China, people suffering oppression set tires and cars and gasoline alight on barricades. The petrochemistry of our protest reflects the materials that we have on hand. Everything we've made, we've made from fossil fuels: energy, food, medicine, and consumer goods.[4] The world has been organized to burn.

As a consequence, the planet is inflamed. Global temperature records are being broken, forest fires have turned from annual to perennial events, oceans are rising, and storms have become bigger and

stronger. This is the epoch of endless fire. Human destruction is tearing apart the web of life, shredding the network of relationships between organisms and places in which our lives are embedded.[5] Inflammation is a biological, social, economic, and ecological pathway, all of which intersect, and whose contours were made by the modern world.

★ ★ ★

Inflammation is triggered when tissues and cells are damaged or threatened with damage. A complex and intricately coordinated response of the immune system, inflammation mobilizes resources to ultimately heal what has been injured. In a healthy, balanced system, once the mending has occurred, inflammation subsides. When the damage keeps coming, the repair cannot fully happen, leaving the inflammatory response running. A system of healing then turns into one that creates more harm.

As we explore inflammation in this book, we will sometimes use the language of the body in analogy. So: salmon are to rivers as hearts are to blood vessels. They both function as nutrient pumps in systems of circulation. We sometimes proceed by simile: dams are like vascular obstructions. We're not above metaphor. Trade routes, for example, are colonialism's arteries, moving people, capital, goods, and diseases around the world system, and connecting bodies, societies, geographies, and ecologies. The metaphor helps us to show that inflammation is systemic and that the systems are linked. But we aren't making a literary argument so much as a medical one. The inflammation in your arteries and the inflammation of the planet are linked, and the causal connections are becoming increasingly clear; your physiological state is a reaction to social and environmental factors. Racial violence, economic precarity, industrial pollution, poor diet, and even the water you drink can inflame you.

These connections are not new or even our own. Indigenous people have been articulating them for the past six hundred years, in an ongoing global resistance to the destruction of their ways of life. Abolitionists have been articulating them since 1619. From the Global South, traditions of healing have survived successive waves of colonial destruction. Our work stands on the shoulders of movement workers and visionary thinkers from the past and our contemporaries, from the agroecological farmers of Amrita Bhoomi, in Karnataka, India, to the lived and theorized struggles for abolition of Angela Davis. We are duly inspired by Robin Wall Kimmerer's braiding together of science and story and the border-smashing articulations of Miles Davis and Frantz Fanon. Our analysis has been shaped by organizing with communities in struggle, and by the stories of patients who pointed the way to the connections we explore. We acknowledge and honor those people whose legacies of resistance have shaped our own understanding. To this foundation of knowledge that precedes us, we hope to contribute a political anatomy, one that can help identify the root causes of humanity's shared pathologies, in our bodies and in the world around us.

Consider the case of Shelia McCarley. She was born on the outskirts of Muscle Shoals, Alabama, on land that had once been Cherokee, a tributary of the Trail of Tears. Power lines strung along the Tennessee River during the New Deal era allowed industries to flourish and gave Alabamians work for a dignified wage. Meanwhile lax regulations permitted the industrial effluent to flow into the Tennessee River. McCarley grew up in Florence, drinking water drawn from the family well. On the weekends, she'd eat catfish pulled from the river with her own hands, fish that had lived and died in water tainted with mercury and "forever chemicals" like PFAS, or perfluoroalkyl substances.[6]

Found in everyday items like waterproof jackets, nonstick pans, and firefighting foam, PFAS are a family of five thousand "forever" chemicals, so called because they accumulate in our bodies and environment and never degrade.[7] They are behind a range of health problems including cancer, thyroid disorders, and immune system disruption.[8] Failure to regulate industrial production has led to their widespread presence in drinking water.[9] Corporations like 3M, which has a production plant on the Tennessee River, spent decades and dollars covering up the negative health and environmental impacts of these chemicals before finally agreeing to settling $35 million for putting PFAS into the water.[10]

When she was in her forties, McCarley left Alabama for California. Early in middle age, her health began to deteriorate. Her face became covered with rashes, her hair started falling out, and her joints swelled. Her body seemed to be attacking itself. At fifty-nine, she was transferred to University of California, San Francisco's Parnassus hospital; her chart declared she was suffering from an

autoimmune disease called lupus.

But something wasn't right. She had some of the classical signs of lupus, like a rash and low counts in her blood cell lines, but the panel of tests that are diagnostic for the disease came back negative. Her illness was a mystery to the hundreds of health care workers who attended her at one of the world's most sophisticated hospitals. Rounds of steroids and other immune therapies did nothing. The most seasoned clinicians and investigators entertained rare and esoteric diagnoses but found no clear match-up with McCarley's course.

The one thing that every physician who saw her agreed on was this: the markers for inflammation in her body were as high as they had seen. It was as if she periodically went into septic shock. Sepsis affects an estimated 30 million people every year worldwide, killing 5 million of them, with the largest burden in the Global South.[11] The acute inflammation of sepsis is directly responsible for at least 20 percent of all deaths worldwide.[12] Typically in septic shock, a person's body sets off intense inflammation in response to an infection or trauma. Body temperature spikes to a fever to fight the offender. It can then plunge into hypothermia as the body fails to correct the offense. White blood cell counts peak and plummet. Blood vessels relax, leading to a dangerous drop in blood pressure. To compensate, the heart beats faster; sometimes people breathe faster, too, and become disoriented.

McCarley had a broad range of symptoms. She appeared to be infected, but no one could find an offending microbe. In the intensive care unit, she received drips of antibiotics and pressors, medication to stop her blood pressure from dropping. After a few days, she seemed better. In addition to quelling infections, antibiotics can also tamp down inflammation. As her symptoms lessened, she was taken off the antibiotics and removed from the ICU. Soon enough, her symptoms returned, so she was readmitted until she'd recovered enough to be released again. The cycle repeated: into the ICU and on a drip, symptoms abated; removed from the ICU, symptoms returned. All the while, there was no evidence of any infection or autoimmune disease.

By the fifth month, she began to despair. She was tired of being poked and prodded, of being offered a glimpse of recovery, only to have it snatched away when her symptoms returned. She asked her doctors to change her goals of care to no longer prolong her life and to allow her to die.

The treatment kept her alive, but eventually it broke her.

McCarley's autopsy revealed that over the course of five months, the marrow in her bones had been replaced almost entirely by activated macrophages. In a normal body, these white blood cells engulf bacteria, viruses, and our own sick or dying cells. But something had triggered her macrophages to go into overdrive—very likely the toxic exposures she grew up around in Muscle Shoals.[13] As the activated macrophages multiplied in her bone marrow, they pushed out other important cell lines, leaving no lymphocytes to respond to infection and no platelets to help clot blood. McCarley became vulnerable to infection and bleeding. She died from both, overwhelmed by inflammation.

To many of the nurses and doctors who still turn over her case in their minds, McCarley was killed by her body's own response to her environment, poisoned by the ongoing exposure to the modern world. But we will never know. Causal relationships are a hard-won scientific prize. It's impossibly difficult to isolate the reasons why McCarley's macrophages behaved the way they did. Over a sufficiently large population, however, it's possible to see patterns emerge. In 2012 a quarter of all human deaths were traceable to environmental factors in the air, water, and soil.[14]

Each toxin works on our body differently. The European Chemicals Agency suggests that there are over 144,000 human-made chemicals in the world today, few of which have been around for longer than a generation or two.[15] The body doesn't have that many tricks to rid itself of chemicals that cause harm. The fallback is to activate its own mechanism of damage control and repair.

But inflammation itself isn't a disease—it's a sign of a larger problem. From McCarley's devastated bone marrow to the clouded lungs of Covid patients,[16] the source of inflammation is more than a virus, or even the poisons with which we humans have contaminated our air and water. To understand why we are sick in the ways we are, we must understand more fully what's driving this phenomenon. What we need is a diagnosis.

DIAGNOSIS: *DIA* (APART) + *GIGNŌSKEIN* (TO KNOW)

Every diagnosis, according to conventional Western medicine, is a story pulled apart, a narrative told

out of joint.[17] The story begins in the middle, with a symptom. Doctors then weave a tale in flashback, one that began with a healthy body that next suffered some insult, trauma, or infection that fits a known pattern of disease. The story of diagnosis—at least the way doctors tell it—concludes with a treatment that may return the body to health at some point in the future, or at least allow the patient to manage the illness. But these kinds of stories don't always work.

Experiencing daily trauma at the hands of law enforcement, acute poverty, hunger, discrimination, forced displacement, and disproportionate exposure to toxins—it all makes people sick. If every diagnosis is a story, and every story begins with "once upon a time in a faraway place," the specific time and place matter.

Recall that in the Covid pandemic, not all patients were equal. Shuffle through the X-rays of Covid-infected lungs, and you'll see a steady rhythm of overactivated immune response; look from bed to bed in an ICU filled with Covid patients, and you'll see patterns emerge. Black, Indigenous, and people of color (BIPOC) were overrepresented, their bodies subject to inflammation of all kinds, long before the SARS-CoV-2 virus ever settled into their lungs. Not only lack of access to health care, but systemic social and economic disenfranchisement rendered their bodies most susceptible to Covid when it hit. Their bodies were vulnerable, and they were at risk for increased exposure to the virus due to the desperate need for an income and whether or not their work was deemed essential.[18] In California, 80 percent of undocumented workers were considered part of the "essential critical infrastructure workforce" by the Department of Homeland Security.

Niria Alicia is a Xicana Indigenous woman who was born and raised in a farmworker community in the Rogue Valley of southern Oregon, in the ancestral homelands of the Takelma people. Both of Alicia's parents immigrated from Mexico to harvest the Bosc and Comice pears that are the valley's signature crop. While Alicia was born a US citizen, her mother was undocumented throughout her childhood, and her father only recently attained resident status. The community she grew up in is made up of farmworkers, hotel workers, restaurant workers, and landscape workers.

In spring of 2020, the pandemic swept the Northwest, and the economy cratered. Low-wage workers were the first to feel the pinch. The Rogue Valley working-class community mobilized networks of mutual aid to ensure everyone could pay their power bills and afford their groceries. But by September, poverty had become widespread and acute. That was when the fires started.

The local government sent out evacuation notices, but only in English and only to the whiter and wealthier city of Ashland, neglecting the poorer towns of Talent and Phoenix, where most of the immigrant community lived. One blaze, the Alameda fire, spread rapidly from North Ashland along a corridor of low-income housing, reducing Phoenix to ashes.

Alicia recalls, "The fire started in the morning. By nightfall, it had already torched some 3,000 structures and 75 percent of those structures are mobile homes owned by low-income white, senior, veteran, and Latinx people. An apartment complex can have six homes, but it is only considered one structure. They say some 3,000 households burned down. If we are considering the Latino community, we have large families. We live intergenerationally. That's likely 5,000 to 10,000 people who have lost everything."[19]

Most of the Latinx community[20] impacted by the fire had immigrated to the valley after being pushed out of their home countries by Washington-enforced neoliberal economic policy, political instability, or climate catastrophe. So like many who had experienced economic disaster, they didn't trust banks. "These workers and grandmothers literally kept their entire savings in cash in their homes," Alicia explains. The Alameda fire burned hot, with some estimates registering 1600 degrees Celsius: "One elder was hoping to find her five-gallon jars filled with all the coins she stashed intact when she rummaged through the wreckage. Instead she found a mess of melted metal." After the disaster, many undocumented people live chose to not apply to the Federal Emergency Management Agency (FEMA) for assistance. "When people realize that FEMA is a part of the Department of Homeland Security, they will be like 'I already lost so much. I don't want to be separated from my family.' So they don't access that help."

The fires delayed the autumn harvest and polluted the air. The average daily air quality index was above 500, levels hazardous to human health.[21] Now unhoused, picking grapes without socks and without N95 respirators, Alicia's community members accumulated the toxic impact of the fires in their bodies. Air pollution from wildfires can cause inflammation in the lungs and the blood vessels, leading to increased risk of heart attack and stroke.[22] It can also predispose people to worse outcomes

from Covid.[23]

Throughout these hardships, the Immigration and Customs Enforcement (ICE), or "La Migra" as the agency and its agents are unaffectionately known, continued their raids in the valley. "La Migra comes. They kick ass. And then they take names. My mom, who is a citizen, could be picked up and put in a jail, exposed to Covid. They have held citizens in these detention camps for months."

The root of a diagnosis is a knowledge of antecedent parts that make sense of the present in order to change the future. Without taking into account the myriad ways systemic injustice impacts the body, the standard medical narrative connecting the past, present, and future falls short, lacking the explanatory power to address and change the course of illness. An accurate diagnosis of Covid in the Rogue Valley must involve a complete history of the arrangements of power that led to certain lives being considered expendable, sacrificed to profits from pear trees planted on land acquired through colonial violence and theft.[24] Put a different way, an accurate diagnosis of the workers in Alicia's community would implicate the systems of injustice created during the colonial era, beginning with the exploitation and enslavement of the Takelma people and ending with a system of racial capitalism that treats migrant workers as disposable.[25] A story that fails to incorporate this history is one that can have no part in healing.

Today's medical and social sciences have a hard time navigating the connections between our health, our histories, and our societies. Academic silos are partly to blame. Hospitalists, historians, and sociologists rarely interact. But even this disconnect speaks to a deeper problem, woven into the origins of modern medicine. Most doctors—most humans, really—have unwittingly inherited a colonial worldview that emphasizes individual health, disconnecting illness from its social and historical contexts and obscuring our place in the web of life that makes us who we are.

In the nineteenth century, the growing field of physiology began to identify the linked systems affecting our health, locating disease in the physical reality of the body. As Michel Foucault wrote in *The Birth of the Clinic*, disease "is caught up in an organic web in which structures are spatial, the determinations causal, the phenomena anatomical and physiological. Disease is now no more than a certain complex movement of tissues in reaction to an irritating cause."[26]

The paradigm shift at that time lay in the recognition that diseases come from *somewhere within* the body's interconnected systems. According to Foucault, it was the job of the doctor to make this location visible and legible. Western medicine then trained physicians to look at an inflamed human body and connect symptoms of inflammation to the dysfunctions of an afflicted organ. In this book, we carry this theory of diagnosis a step further, locating the causal origin of disease in the multidimensional spaces around and beyond the individual body—in histories, ecologies, narratives, and dynamics of power. The inflammatory diseases we are seeing today are not the cause of the body's dysfunctional reactions. They are the body's correct responses to a pathological world. To understand what's driving inflammation, we must account for the things our bodies have been exposed to, in the places where our lives have been circumscribed. And to offer a treatment, we must show how we can escape.

The philosopher David Abram observes that "the body is itself a kind of place—not a solid object but a terrain through which things pass, and in which they sometimes settle and sediment."[27] To wonder why some things settle in some bodies and not in others is to begin to ask questions about power, injustice, and inequity, questions that are bound in modern medicine with questions of colonialism.

PILLAGE AND PLUNDER

Indigenous communities will tell you rather bluntly that colonialism is far from over. There are over seventy countries with Indigenous people whose lives are under threat by colonial expansion today. In 2018, 164 Indigenous people were killed in defense of their land against mining and agriculture enterprises.[28] Some of the world's most important economies, such as Australia, Canada, Brazil, and the United States, are settler colonies, and their projects to remove Indigenous communities' control over their land are ongoing.

Despite some annual rituals of contrition—Sorry Day in Australia,[29] Indigenous Peoples' Day spottily observed in some US states and cities, a cosmetic apology for genocide in Peru[30]—most

countries have a state-sponsored policy of amnesia around the fate of Indigenous people. Since 1942 the United States, home to 573 federally recognized tribal nations,[31] has required schoolchildren to forget that number and each morning pledge their allegiance to "*one* nation under God."[32]

The litany of health disparities that Indigenous communities suffer presents a painful pattern. In Cameroon, members of Indigenous Baka communities will live on average until they are thirty-five years old—that's twelve years fewer than the country average. In Russia, Indigenous Nenet women are six times more likely to die in childbirth than the national average. In Australia, aboriginal infants die at almost twice the rate of settlers.[33] On the Pine Ridge reservation, Oglala Lakhˇóta lifespan is sixty-six years old, while neighboring settlers in South Dakota can expect to live to seventy-five. Settlers living four hundred miles away live to eighty-six.[34]

Chances are that you are not among the world's 370 million Indigenous people. But colonialism affects you, too. Whether you're living in a settler colony in the Americas, in a part of the world controlled by European empires in Asia or Africa, or in Europe itself, the ideologies of modern colonialism are alive and well—and they are making you sick.

To be clear, colonialism isn't simply the physical occupation of land. It is a process, an operation of power in which one cosmology is extinguished and replaced with another. In that replacement, one set of interpretations about humans' place in the universe is supplanted. Patterns of identity, language, culture, work, relationship, territory, time, community, and care are transformed.[35] Colonialism has fundamentally altered our relationships with the web of life, and we are all living with its consequences. When Europe began its pillage of the Western Hemisphere in 1492, Indigenous cosmologies of reciprocity, relationships with and duties of care for water, land, and living beings were uprooted, replaced with a worldview animated by domination, exploitation, and profit.

In one of Christopher Columbus's diary entries, written on seeing the Western Hemisphere for the first time, he noted that he had seen all manner of unidentifiable living things and that he couldn't figure out how much they might sell for. There was, however, one commodity with which he was familiar, from his early years around the slave markets of Genoa: humans. On his first return from Arawak territories, he brought with him a hold full of slaves for the market in Seville.[36] It was the beginning of centuries of extraction and enslavement.

To understand how colonial cosmology has transformed and disrupted the web of life, consider the case of the beaver. Beaver was the most prized fur in Europe; its fur is naturally water repellent, and haberdashers across the continent used the underpelt to waterproof hats. What was once a practical item of clothing to keep you dry in the rain soon became a must-have fashion item across Europe. But by 1600 the European beaver was hunted to near-extinction.[37]

Enter colonialism. From 1822 to 1890, the United Kingdom imported 74 percent by value of all US fur exports.[38] Before Europe colonized the Western Hemisphere, there were 60 million to 400 million beavers in North America.[39] By 1900, they were all but extinct. Today there are around a tenth of their original number.[40] In some cases, Indigenous people were enslaved to serve the European demand for fur.[41] Disease introduced by Europeans also traveled along these trade routes.[42] In settlers' attempts to exploit Indigenous peoples for profit, they altered the bodies of these communities for generations.

The fall of beaver populations also changed the way rivers ran across the North American continent. The biodiversity that thrived because of the beaver's hydrological engineering plummeted. With their dams, beavers create successional habitats that provide slow-moving water sanctuaries for plants, insects, and other animals, such as salmon. As demand for pelts pushed trappers west across the North American continent, beaver pools disappeared.[43]

Rivers without their beavers flow straighter and offer less safe harbor, particularly during winter freezes. The annihilation of the beaver and its habitat reduced the number of potential salmon smolts in winter by 94 percent.[44] For Indigenous communities dependent on the salmon, this was devastating.

Rates of diabetes, cardiovascular disease, and depression skyrocketed in the Indigenous communities of Salmon Nation. Defined as "a nature state, as distinct from a nation state,"[45] Salmon Nation is the coastline and watershed spanning the fifty thousand square miles between the Yukon River in Alaska and the Sacramento River in California, where the Pacific salmon run.[46] The lives of Indigenous inhabitants are intricately intertwined with the health of the salmon, whose vitality is seen as a reflection of their own. The process that extirpated the beaver, changed the course of the waterways, and removed the fish from rivers is the same one that has left tribal people's bodies

wracked with inflammation. The consequences of this colonial trade are still visible both by satellite and under the microscope.

Just as it altered the flows of water around the world, European colonialism brought flame. One member of the Belgian colonial forces in the Congo detailed, "As our party moved through village after village ... a party of men had been detailed with torches to fire every hut ... As we progressed, a line of smoke hung over the jungle for many miles, announcing to the natives far and wide that civilization was dawning."[47] The destruction of tropical forests, and of the cultures that live in those forests, isn't over. Australia has lost 40 percent of its forest cover since European invasion,[48] and battles over the future of extant land continues to be prosecuted between Indigenous communities and logging companies: one side sees the promise of profit, and the other sees life and culture being butchered by chain saws.

That one person's progress might be another's destruction has much to do with the intellectual life of European colonization. With a new continent to plunder came new ideas to license the theft. The fifteenth century saw the simultaneous inauguration of European empire and the ascendency of a scientific worldview that objectified and diminished life and the natural world.[49] The psychic technology crucial to justifying the expansion of empire was the invention of the diametrically opposed concepts of "society" and "nature." Humans who were capable of allegedly rational thought—usually white, Christian, landowning men—comprised "society." The rest of the planet—non-Europeans, women, animals, rivers, and plants—were defined as "nature," purely physical things without minds.

The seventeenth-century philosopher René Descartes, who spent much of his life in the Dutch Republic during its Golden Age of imperial conquest, codified an intellectual framework through which colonists could split the world into thinking and unthinking things. From his *Meditations*: "I think, therefore I am." Grounding existence in the experience of the self, Descartes concluded, "I am a thinking thing," and "I am not this body."

That he wasn't just dreaming about his body, that his perceptions of it were indeed real, was vouchsafed by God.[50] With a guarantee like that, the world was his to master. The separation of mind and matter allowed for, indeed demanded, the cleavage of the world—into material things and thinking things, into domains of the physical and the spiritual. This dualism of mind and body is fundamental to colonial cosmology and permeates every institution created through colonialism—especially medicine.

In the colonies, Europe's imperial projects specifically targeted the foods and medicines of colonial subjects to make them easier to dominate. Through campaigns that merged official medical knowledge and armed force, European missionaries and medics waged war on Indigenous shamans and healers. Physicians were a part of the violent colonial project, bringing new medicines and conceptualizations that dissected Indigenous peoples apart from their ways of knowing and consequently from their health. Campaigns against witchcraft and the ignorance of colonized people were lessons in the brutal imposition of a colonial worldview.

Colonial cosmology sees *things* where *persons* once were. What once was alive with personhood—a forest, a river, a mountain—becomes inanimate, disconnected from ecologies, open to exploitation. In the United States, this mindset is enshrined into law. Attempts to confer legal rights of personhood to Lake Erie were struck down by the courts, while laws that bestow on corporations the rights of people continue unchallenged. And there's a reason: it's easier to scoop the heart out of a mountain when it's a resource than when it's a living relative.

Many people don't realize that the same will to power that is ravaging Indigenous communities around the world is making the planet and most of its inhabitants sick. But what's worse, the medicine we rely on to heal from these insults is itself rooted in colonial cosmology. The history of modern medicine *is* the history of colonialism. It's no wonder we're not feeling any better.

BUT MODERN MEDICINE IS GREAT

We're often told that we've never had it so good.[51] Even amid the Covid pandemic, medicine points toward cures. Life expectancies are on the whole increasing, maternal mortality is falling, and childhood stunting looks like it might be a thing of the past. But this celebration of the past two

hundred years is possible only in the same way that a banker, plummeting off a ledge, is able to say "so far, so good."

Look closer, and the story gets more complex. In the UK, severe cuts to the safety net, over the last thirty years, have led to a plateau on life expectancy since 2009.[52] In the United States, life expectancy has fallen for three consecutive years since 2015, and this was before Covid reduced life expectancies for white, Black, and Latinx people by one, two, and three years respectively.[53] Maternal mortality rates in the United States are dismal, and in New York City, in this century, you are twelve times more likely to die after having a baby if you happen to be a Black woman than if you are a white one.[54] Globally, the number and proportion of hungry people is increasing and has been since 2015.[55] The Covid pandemic points to a systemic vulnerability in global health and health care systems.

Defenders of modern medicine can concede these points and still celebrate that, for instance, we no longer have to suffer smallpox, a disease that was once endemic in Europe and Asia and that was brought to the Western Hemisphere through colonization. The story of smallpox's elimination is, in miniature, the story of colonial medicine.

Edward Jenner is often credited as "the father of immunology" for having developed the smallpox vaccine.[56] Famously, people working in dairies, often women, already knew that a bout of cowpox conferred immunity to smallpox.[57] But it took Jenner to introduce the idea into the circles of medical knowledge—for this "old wives tale" to get the imprimatur of medical authority. He conducted experiments on young working-class boys, infecting them with cowpox and waiting to see if they then contracted smallpox. He wrote up his findings in the right kind of media, and medical knowledge was produced. Such was the success of his work that other European countries embarked on extensive vaccination campaigns.

The cowpox needed to be brought over in living human bodies. For this purpose, uninfected orphaned boys were taken from Spain and a chain of infection created between them, so that at any given time, at least one had productive cowpox boils. Four of the sixty-two boys died in the sea voyages of the 1803–13 campaign. Tens of thousands of people were vaccinated, and thousands of lives were saved. In the process, modern medicine eliminated existing pathways of knowledge and built temples to its own.

To be clear: we are supporters of peer-reviewed science, and we reference it widely throughout this book. Our concern is that the modern medical industry patches up bodies broken by the same system through which medicine itself was produced. It takes work to ignore the gradients of power across class, race, gender, and histories of genocide, enslavement, and theft. Modern medicine is, we'll argue, premised on the will to power, a systematic domination not just of some humans by others but of the domination of humans over other beings in the web of life. Let us call this practice of domination "colonial medicine." By ignoring the injustices that have produced it, and in which it participates by commission and by omission, colonial medicine is complicit in the damage it purports to heal.

A good example of this colonial sleight-of-hand is clear in a glass of water. The demand to stop fluoridating municipal water supplies is, in the United States, sometimes derided as paranoid. Sodium fluoride has been proven to reduce dental caries when applied to teeth. Caries are painful and can have long-term health effects. Low-income children are particularly prone to dental caries. If you remove fluoride from water, as Juneau, Alaska, did in 2008, the average number of cases of dental caries in children increases, in that case from 1.55 to 2.52 five years later.[58]

So is it a crime, as is so often represented in common sense, against poor children to stop fluoridation? We don't think so. It's possible to understand why children in low-income households have poor dental health, and to want to tackle that problem without subjecting a wide population to chemicals that have, surprisingly, a very thin epidemiological history.[59] While fluoridation may have emerged in the 1940s as a low-cost public health intervention to manage working-class dental problems, today it is a billion-dollar subsidy for the fertilizer industry, in which hydrofluorosilicic acid is a by-product. This industrial waste has found a lucrative afterlife in water supplies around the world.

Recent findings of neurological changes in children exposed to fluoridated water are surprising only because no one thought to look before to see what would happen if humans took a chemical that had been proven to protect teeth only when brushed onto them and then spat out, and started drinking it every day.[60] Resisting fluoridation doesn't mean condemning poor children to pain and future dentures: it's understanding how industrial chemical companies make it easier to think about

dosing an entire city rather than spend money on free dental care for the poor.

If fluoridation skeptics have a point, might a similar case be made for Covid skeptics? A survey in March 2020 suggested that nearly 40 percent of people in the United States thought the threat of Covid was blown out of proportion (54 percent of Republicans held this view versus 20 percent of Democrats), and 23 percent of rural people in the United States don't trust public health officials.[61] Almost everywhere, the pandemic has been politicized, and monetized, but this is nothing new. The World Health Organization identified "vaccine hesitancy" as a major public health threat in 2019, before the pandemic.[62] Leading the world in suspicions around vaccines are countries like France and Japan, where worries about medical safety are suffused with a distrust of the prevailing political class and the veracity of government information.[63]

How, then, can we condemn Covid deniers and still find fault with modern medicine? Like them, we're skeptical of authority and suspicious of those seeking to profit off a disaster.[64] The difference lies precisely in that the community constituted by saying no is, in our case, one that has a far longer history. We're not individual small-government conservatives of Reagan's vintage, or fearmongers of the Deep State. Along with Indigenous healers, we have a more nuanced understanding of health, power, and the colonial state. Our skepticism and refusal are rooted in science, not in a rejection of it. This is why our book doesn't pull away from the science we need to understand the biology, chemistry, physics, and ecology of inflammation. For those who haven't had the opportunity to read science beyond high school, we offer this book as an invitation to gain skills that have been denied you by a society that is increasingly skeptical of any kind of peer-reviewed science and that walls education away from the masses.

Our path through vaccine skepticism recognizes the history of mistrust and abuse that communities—particularly BIPOC people—have suffered at the hands of medical and state power, and we offer a collective solution.[65] We embrace a vision of liberation grounded not in rugged individualism but in collective decolonization.[66]

DEEP MEDICINE

There is a medicine that is mindful and active in resisting colonial cosmology. Fighting the damming of rivers, the invisibilizing of Black pain, the clear-cutting of forests, the incarceration of minorities, the monocropping of foods, the poor health outcomes of Black and poor people, the land theft and genocide of Indigenous people, the wage gap, and the attempts to control women's reproductive power is all part of the healing arts that we call "deep medicine." It's a practice that any healer can begin immediately. It starts with the act of repairing those relationships that have been damaged through systems of domination.

In 2008 a young radiology resident, Yehonatan Turner, felt frustrated reading CT scans without knowing anything about the patients as people. He started including a photo of patients' faces alongside their scans and then studied the impact on radiologists, who could see the person whose images they were analyzing. All radiologists involved with the study reported feeling more empathy toward the patients after seeing the photograph, and in turn, the interpretations they gave were more "meticulous."[67] Rehumanization can begin with something as simple as looking at a photograph.

Human bodies are rendered alien from doctors through the rituals of education in biology. Most humans get some version of this biological miseducation in high school, and it is how most of us are taught to relate to the web of life. The school system teaches us to amputate our concern for other living beings and for the land itself. Animals are just meat, land is just a commodity, work can be bought and sold, humans are a resource, and everything else a means of production. The result is our license to use animals in any way we see fit and to be able to trade in land. This is how life and territory are orphaned from humans.

Rehumanizing, then, means seeing not only the human behind a CT scan but the more-than-human behind the picture of any individual. Our bodies have evolved in systems of deep relationships with the sun, soil, water, tides, seasons, archaea, bacteria, viruses, animals, plants, fungi, and the rest of the teeming world. Each of those depends on relationships with one another. The study of ecology is becoming indispensable to the study of medicine because humans are not just a single animal, but a multitude, an ecology of beings living on us, in us, and around us.

Studying the ways in which systems interact to create health or illness is the leading edge of a revolution of understanding in medicine. The reductionist understanding of disease in singular terms, such as one gene encoding one faulty protein or one drug targeting one receptor, can get us only so far. We evolved as systems within systems. There is nothing singular about us.

Today, instead of simply looking at the impact of one single gene, geneticists are looking at multi-omics, global assessments of processes and molecules that can give a more accurate picture of what is happening in a living being in states of health or disease.[68] Systems-level understanding is yielding important new understandings in medicine and in the very concept of health. Our anatomical systems are embedded in more systems—ones that humans have engineered and that make up our surrounding ecologies. At this space of intersection, the medical imagination is limited. Computing the total world of exchanges between the webs of life around us is a massive undertaking. Understanding how they interact to create harmony or dissonance is critical to mapping the future of health and life on the planet.

Decolonizing medicine begins with the project of rehumanization and reconnection, linking scans to people's faces; patients to their families, their cosmologies, communities, and histories; peoples to their lands and mountains and waters; and relatives to one another across the vast web of life. It is a process of imagining a "we" that is bigger than the sum of you and me. It involves a far wider community than Facebook can ever offer. It is the process of healing what has been divided and conquered. Resistance to colonial medicine is grounded in radical imagination: radical not as in somehow inconceivable or unattainable, but as prison abolitionist Angela Davis describes, as in "grasping things at the root."[69] Decolonizing is training our gaze on the origins of suffering in order to uproot them. It is the ambition to build a community of respect for the "animacy of life itself."[70] In a pandemic, it is recognizing that the source of the problem is not the vaccine or the billions that are made from it, but the fundamental disconnection from fellow living beings that allowed the disease to flourish in the first place.[71]

Disconnection lies at the heart of the origins of Covid. Indigenous communities have always taken animal lives, in ways that have respected and been grateful for those lives. But through decades of deforestation and habitat loss, we've forced those animals closer together. Animals that might have encountered each other only rarely are encountering one another far more often. Herein lie the origins of the interspecies jumps that likely produced Covid and that will produce the next pandemic: 60 percent of human infectious diseases come from pathogens that jump from other animals.[72] The industrial systems that turn animals into commodities make it easier for this to happen.[73] In 2009 H1N1 came from industrial pig production, possibly from the US-Mexico border. Covid mutated new infectious variants in the confines of Danish mink farms.[74] The global common denominator is a human supremacy over life that cannot fathom a greater intelligence than our own.

In Lakȟóta territory, elders will tell you that the damming of Mni Sose (the Missouri River) was the first moment in the cascade of events that led to now-endemic rates of diabetes. Traditionally, foods and medicines were gathered in the cottonwood forests at the banks of the river. But damming the river flooded these forests, and as this rich, sustaining ecosystem was lost, so too were the memories and traditions of how people had nourished and healed themselves for thousands of years. The people became increasingly sedentary and relied on food and medicine brought in by colonial forces through colonial structures that persist today. Rates of diabetes skyrocketed and have remained elevated ever since.

The Itázipcȟo and Oóhenuŋpa Lakȟóta elder Candace Ducheneaux believes the diseases that afflict the industrialized world are diseases of colonization. "The heart disease, lung disease, obesity, depression, diabetes, cancer, Alzheimer's, and auto-immune diseases which are so commonplace now never existed before the colonizers came," she says. Analysis of the remains of Indigenous people from the time before European invasion confirms her assessment. The excavated bones of precolonial ancestors show the presence of infectious disease, most commonly from *Staphylococcus* or *Streptococcus*. They reveal that anemia was common; abraded knees point to widespread degenerative joint disease. But the bones show no signs of diabetes.[75]

If you find yourself more convinced by studying skeletal remains than by listening to the oral histories of Indigenous people, you're a participant in a colonial system of organizing truth. Reconstructing history through bones misses much that oral histories capture. Yet in a colonial world,

stories passed down by Indigenous elders cannot be considered true until they are validated by the empires that colonized them.

Colonialism has altered our relationship to knowing and understanding. It has altered the relationships that Lakhˇóta people—and all people—once had with the world around them. It has policed what can be regarded as science, and who can be peers in review. More than that, it has severed a relationship to the past, to a cosmology that helped point to vital relationships between beings.

Colonialism has changed the architecture of how we live, imposing objectifying and extractive structures on cosmologies thousands of years old. It has changed how stories are told and which ones are told and which ones are forgotten. These structures persist and continue to wreak havoc on individual bodies, on our societies, and on the planet. Its signature is damaged relationships, and the outcome is inflammation. Nowhere is this clearer than in the practice of colonial medicine, which focuses on the individual to keep the systems invisible. Our individual healing is connected to healing our society, and our healing of the ecosystems upon which our lives depend. To engage in this holistic vision is to practice deep medicine.

THE ANATOMY OF INJUSTICE

Practitioners of modern medicine are not trained to be healers. They are trained to be biomedical technicians. When the causes of poor health lie outside the patient, in the environment or in society, doctors are frequently at a loss. Hunger, for instance, isn't considered a disease that falls under doctors' purview—a sign of how broken modern medicine has become. Doctors are trained not only to look exclusively at the patient as a solitary individual—shorn of context or structure, stripped of life in all its complexity—but to treat that individual as a broken machine, as a dysfunctional and occasionally noncompliant robot bearing a symptom. This is a relic of colonial thinking.

We have laid out this book as a subversive political anatomical survey, taking individual bodily systems and showing how ancient and modern science connects that body to the web of life through histories and relationships of power. Each chapter isolates one system of the body—immune, circulatory, digestive, respiratory, reproductive, skin, endocrine, and neurological—as seen through Western medicine. We want to take this familiar, disconnected understanding of health and make it strange by extending the borders and limits of those systems, weaving into them silenced histories, invisible ecologies, molecular movements, and mythologies. As such, we outline a cartography of illness, drawn by lines of power, in hopes of uncovering a path to a future where health in its broadest terms might be possible.

We use oral histories, historical source material, and peer-reviewed literature from several branches of knowledge to build our understanding of the interactions between the body, society, and the planet. While some of the studies we draw from speak directly to causation, many of the more recent data we cite outline powerful associations. These associations are often the first step in pointing scientific inquiry down the paths to more detailed conclusions around cause and effect.

For every example of colonial inflammation, we offer deep medicine, ways of thinking through how we might find one another through the work of decolonizing and through building communities of care. Since the diagnosis is systemic, our prescriptions are too. We don't offer encouragement to shop organic, to buy supplements, or to use apps for mindfulness. Decolonizing is not something that can be done alone. But it is already happening in communities where land is being rematriated, where solidarity economies of mutual aid and support are being established, where communities are renewing their relationships with local ecologies and retelling their stories, some of which have been silenced for centuries.

For Indigenous communities in North America, the act of connecting young people back to their ancestral lands is cutting suicide rates without the use of Western medicine or pharmaceuticals.[76] Having a sense of belonging improves health outcomes. Cultural continuity and dignity are in themselves determinants of health.[77] These benefits are available and relevant not to Indigenous people alone. They are a path for all of us who must learn to relate differently than in the prescribed ways—and with the proscribed identities—that colonialism has created for us.

For many, this won't be an easy book to read, because it *can't* be an easy book to read. Colonialism

has made the institutions through which we daily become who we think we are. Historically it fashioned schools, hospitals, prisons, corporations, borders, charities, militaries, farms, and homes, whether in settler societies, postcolonial countries, or in colonial metropoles. Confronting that is difficult work, particularly because treating the inflammation we are collectively facing requires us to understand the dimensions of pathological thought that brought us here.

For some, especially those who are most impacted by colonialism's violence, certain sections of the book may feel traumatizing. The same may be true for those whose privilege comes through that violence. It was hard to write this book because it required taking an unflinching look at how we've been made by those histories. But with communities of care, it's possible to build a better world through that discomfort. Read together, out loud, if that helps. We're calling not for individual shame and therapy but for its political opposite: a collective reckoning, transformation, healing, and justice.

Decolonizing invites us to stretch our diagnoses back to a time when the concept of *the self* mattered less than the relationships upon which our lives depended, from the microbes inside us to the world around us. It calls on us to develop new methodologies of diagnosis, ones that center other ways of telling our stories and other ways of knowing that connect us to entities beyond our skin. Instead of pulling apart to know, we are bringing together to understand. This kind of diagnosis situates our damage and our healing more clearly in the past, present, and future.

We are grateful to you, our ancestors, our families, the ancestors of the stolen land on which we ourselves write and to their descendants who are still here, to the healers and holders of science before us and the web of life through which we have been able to write this book. We hope that your journey along this path will be as revealing as ours was as we wrote these words, and that by the book's end you will find yourself, as we have, a far more plural being.

1

IMMUNE SYSTEM

I AM BECAUSE YOU ARE

> Biology is about recognition and misrecognition.
>
> —DONNA HARAWAY[1]

> The role of the physician is to translate "medically unknown symptoms" into social problems.
>
> —NANNA MIK-MEYER[2]

> What do you call second-class citizenship? Why, that's colonization.... They try and make you think they set you free by calling you a second-class citizen. No, you're nothing but a 20th century slave.
>
> —MALCOLM X[3]

The body has an ancient and powerful mechanism to heal itself: the inflammatory response. Inflammation occurs when the body's innate immune system responds to damage or a threat. Inflammation can be acute or chronic, localized or systemic, but it involves a whole host of cells and molecular messengers participating in a complex, choreographed set of interactions. The goal is repair and recovery—restoration of the body's optimal working conditions, a state called homeostasis.[4]

The acute inflammatory response is a time-limited event. Activity increases sharply in the face of a threat or injury and then resolves when the threat has passed and the damage is repaired. Once healing is complete, specific regulating molecules turn off the response.[5] Sometimes, though, the response doesn't switch off, and the result is a chronic systemic inflammatory state. When that happens, the body's healing mechanism is transformed into a smoldering fire that creates ongoing harm. The result is a crucial breakdown in the immune system's ability to repair damage and restore homeostasis.

Acute inflammation can begin with an infection, when innate immune cells recognize molecular signatures found on the surface of bacteria, fungi, or viruses called pathogen-associated molecular patterns. These signatures haven't changed much over millions of years of evolution, and because humans have evolved in tandem with these organisms, our innate immune cells have developed ways to recognize them. Acute inflammation can also be triggered by cellular injury. In this situation, damage-associated molecular patterns, which consist of cellular debris, are released in response to physical or chemical injury.[6]

Following activation by these molecular patterns, tissues and immune cells release a host of

signaling proteins called cytokines. Some of these messengers amplify inflammation—they're called pro-inflammatory—and other, anti-inflammatory ones abate it. Pro-inflammatory cytokines—interleukin-1β (IL-1β), interleukin-6 (IL-6), and tumor necrosis factor-α (TNF-α), for example—keep the inflammatory response cooking. They stimulate the release of other inflammatory mediators, such as C-reactive protein (CRP) from the liver. These are some of the key biomarkers currently used to track acute inflammation.[7]

The acute and chronic inflammatory responses share some important characteristics and molecular mechanisms, but they also differ in essential ways. While acute inflammation is triggered by molecular patterns both from pathogens and from damages, chronic inflammation is prompted in the absence of infection. It is set off by damage-associated molecular patterns and other SOS signals from living cells that are under duress.[8] As such it is often referred to as "sterile" inflammation. Hormones and nerve signals that respond to psychological stress can set off these SOS signals.[9] So can air pollution and other characteristics of modern life. When the inflammatory response is sustained from repeated triggers, molecules generated by innate immune cells in response to these SOS signals create collateral damage. Add to that damage from an entire lifetime of exposures that generate more inflammation, and the body never has a chance to repair.

Acute inflammation can occur at any age, as we know from the toddler with an ear infection or the teenager with a skateboarding injury. But chronic inflammation happens only with advanced age. The older you get, the more likely you are to suffer from it; not only that, it ages you disproportionately. Your birth certificate might claim you're middle-aged, but you could clock decades older on the inside. This close relationship between aging and inflammation has led to the clever neologism "inflamm-aging."[10]

Central to this relationship is cellular senescence, the process by which aging cells permanently stop dividing but remain metabolically active. Under certain conditions, some senescent cells go on to express the senescence-associated secretory phenotype.[11] This functional change transforms them into vigorous producers of the pro-inflammatory cytokines and other molecules that drive systemic inflammation. Mounting evidence indicates that senescent cells with this phenotype are involved in the onset and progression of the age-related diseases of chronic inflammation, such as cardiovascular disease, diabetes, chronic kidney disease, chronic obstructive pulmonary disease (COPD), osteoarthritis, and Alzheimer's.[12] These cells may be driving the runaway inflammation of severe Covid in the elderly[13] and the pathology in autoimmune diseases, such as rheumatoid arthritis.[14]

But not all aging cells develop this phenotype as they become senescent. Ones that do have accumulated a lifetime of cellular damage due to a variety of exposures.[15] While both endogenous and external factors can drive the development of chronic inflammation, a study documenting 210 healthy twins found that external factors—environmental and social—had the biggest influence.[16] Damaging exposures are the game changer, converting our aging cells into ones that do us harm.

The sum of lifetime exposures to nongenetic drivers of health and illness, from conception to death, is called the *exposome*.[17] The exposome encompasses chemical, social, psychological, ecological, historical, political, and biological elements that determine whether aging cells will become drivers of chronic systemic inflammation.[18] The exposome of modern industrial societies is rife with triggers for inflammation-related diseases. Modern diets contain more processed foods and less fiber, both of which can alter the gut microbiota population and function, leading to changes in the immune system that can create inflammation.[19] When we are physically active, skeletal muscle releases anti-inflammatory cytokines called myokines,[20] but modern lifestyles increasingly limit the occasions for strenuous activity. Some cities are entirely unwalkable, necessitating travel by car. There's a reason that doctors are forever telling you to eat more fiber and get more exercise.

The exposome of modern life differs radically from that of Indigenous and traditional people who maintain critical relationships with the living systems upon which their lives and health depend.[21] While systemic inflammation and its accompanying diseases have increased dramatically across industrialized societies,[22] they remain rare in traditional ones, such as the Shuar hunter-gatherers of the Amazon,[23] the Hadza of Tanzania,[24] the Tsimané foragers who tend the forests of Bolivia,[25] the horticulturalists of Kitava, Papua New Guinea,[26] the subsistence farmers of rural Ghana, and even the Irish Travellers before they were recently forced into settled modern housing.[27] Members of these groups are exposed to a variety of microbes and infections, but they do not show the same chronic

systemic inflammation that drives modern noncommunicable disease.[28]

The immune system is toned by the exposome, much the way a muscle is toned by exercise or a guitar string is made taut by turning a tuning peg. Immune systems toned by damaging exposomes seem to respond to an insult like Covid with overwhelming inflammation, like a string being pulled too tight. Severe Covid is overexpressed in socially oppressed groups.[29] Early in the pandemic, in the Zhejiang Province of China, severe cases were more often seen in agricultural workers and less frequently in people who were self-employed.[30] This trend repeated around the world.[31] An exposome that counteracted damage, making room for more care—like giving workers a guaranteed income so they could stay home with their families during the pandemic—would allow for a more measured immune reaction in the face of a real or perceived threat.[32] The interaction of the exposome with the genome gives rise to the disparities we see in health and illness across different demographics. While genetics play a part, the exposome's impact, we argue, is more immediate and, importantly, more alterable.

Were we writing a simple how-to book, we might point to ways you as an individual could address the pro-inflammatory exposome of the industrial world. For example, disruptions in circadian rhythms caused by the blue light from a phone at night lead to an increase in inflammation-driven diseases such as diabetes, depression, high blood pressure, and obesity.[33] So you could simply download an app that turns blue light to yellow at night. Or you could take melatonin, which has potent anti-inflammatory properties.[34] But many exposures aren't optional. They are systemic. Those who are working the night shift,[35] experiencing job stress, debt, and economic precarity,[36] enduring trauma from surviving genocide or police killings,[37] living with industrial waste,[38] noise,[39] and wildfire pollution[40] are people for whom exposure is rarely a matter of choice. The combined impact of the modern exposome is a shift in the inflammatory response, from one that heals to one that harms.

This damage is a consequence not of individual choices but of the mandates of a certain social, economic, political, and environmental ecology. To see these connections, and then repair them, is not to pine for a preindustrial lifestyle. It is instead to reject the logic of personal responsibility when so much of what shapes our health is beyond individual control. Once you see it, it's impossible to make peace with a world that causes this systemic harm—not without wanting to change it. This activation is what the philosopher Alain Badiou calls "exile without return," a practice we must apply to our medical approach. One must banish oneself from an empire of institutionalized medicine built on injustice and build a better way of healing, along with others committed to the same vision.[41]

Ideas of expulsion and belonging are ones that medicine deals with rather centrally. When you say you're shrugging off a cold, or fighting an infection, you're invoking a language of self-defense, together with an understanding of what should remain within the bounds in your body and what should not. No branch of medicine deals more directly with those issues of territory and belonging than immunology.

THE *IMMUNES* STRIKE BACK

The word *immunity* derives from a legal quirk of the Roman Empire. *Munus* in Latin kicked off the English word *municipality*. *Munera* (the plural of *munus*) were the duties that Roman citizens were obliged to perform.[42] As the Roman Empire expanded, it extended a kind of second-class citizenship to nonmunicipal cities within the boundaries of its empire. Foreign residents of these *civitates liberae et immunes* were not properly Roman in the same way as Rome's nonslave male inhabitants. They were thereby exempt—*immune*—from the duties that made them fully Roman.

It is unclear whether Rudolf Virchow, one of the founders of modern medical immunology, knew of this history, but he certainly understood what it felt like to be *immune*, to be within a world yet estranged from it. During the Revolutions of 1848, Virchow was both a citizen of Berlin and not properly of the Berlin in which he found himself. He was armed and ready to fight the old world so that the new world might be born. The Prussian forces "shot at us from a great distance, out of range for a pistol," he reported from atop the barricade.[43]

Virchow wasn't alone. The Revolutions of 1848 reverberated throughout Europe and the world. From Finland and France to Chile and Brazil, restive urban workers recognized their second-class citizenship and rose up to demand justice—equality, better working conditions, a political and social

voice. Within the literature that informed the uprisings, *The Communist Manifesto,* which first appeared in German in February 1848, is perhaps the most widely known. It is no coincidence that just a few years earlier, in 1845, one of its authors—Friedrich Engels—had written an epidemiological work, *The Condition of the Working Class in England*.[44]

In order to write it, the twenty-four-year-old Engels had excused himself from "the dinner-parties, the port-wine and champagne of the middle classes," to spend time in conversation with Manchester's working class.[45] He used ethnography, epidemiology, geography, and class analysis to account for why he found "the rate of mortality four times as high in some streets as in others, and twice as high in whole classes of streets as in other classes."[46]

Clearly, Virchow had read Engels.[47] In 1848 he and his colleague Rudolf Leubuscher editorialized in their new journal *Medical Reform* that "medicine is a social science, and politics nothing but medicine on a grand scale."[48]

Virchow was born into a farming family, but one well-connected enough to secure his admission to the best medical college in Berlin, where he proved an exceptional student.[49] In 1848, at the age of twenty-six, he was appointed to a governmental commission to investigate an outbreak of typhus in Upper Silesia—what is now modern Poland and Czechia—a region that had been annexed by the Kingdom of Prussia and was under the domination of its German-speaking aristocrats.[50] While he was there, he saw how disease and hunger ran together, in "a devastating epidemic and a terrible famine."[51] His diagnosis was a social critique:

> The worker has been permitted to demand the means of his subsistence, he has been guaranteed work to enable him to acquire the means, there were those highly praised Prussian schools to provide him with an education appropriate to his class and, finally, the sanitary police were entrusted with the task of supervising his living conditions. And what an army of well trained civil servants were available to enforce the laws. They intruded into private affairs, watched over the most intimate social relations, and assiduously patronised any attempt on the part of "the subjects" to improve themselves. The law was there, the civil servants were there, and yet thousands of people died of famine and epidemics. The laws were useless, for they were nothing but words on paper. Similarly the actions of the civil servants merely resulted in words on paper.... The civil servants had not been appointed by the people to serve their interests. Rather they were appointed by the police state and to serve the interests of the state. Thus, the civil servants were either the oppressors of the people or mere typewriters.[52]

A radical new political vision was needed to address the impact of Prussian imperial rule on public health. Lack of education in the native language, "the Catholic hierarchy," and "the great landed proprietors" were the silent vectors of the typhus epidemic.[53] And the doctor's prescription: "education in the Polish language; self-government, separation of church and state; shifting of taxes from the poor to the rich; improvement of agriculture; development of cooperatives; and the building of roads."[54]

Like epidemics, famine is neither natural nor inevitable. The widespread hunger that Virchow witnessed in Upper Silesia was a policy failure driven by external events, ones that swept across Europe. The market economy was being brutally enforced throughout the continent. In England's first colony, Ireland, a lack of genetic diversity had left the potato crop vulnerable to infection by a fungus. From 1845 to 1849, a million Irish citizens died from famine. And yet in 1846 Ireland exported 500,000 pigs and 30,000 tons of grain to England, where prices were higher. The Irish died for want not of food but of money to buy it.

When local government officials in Cork proposed paying Irish laborers higher wages for a public works program that would allow them to buy food for their families, *The Economist* scolded them for the error of suggesting

> to pay them not what their labour is worth, not what their labour can be purchased for, but what is sufficient for a comfortable subsistence for themselves and their family. Do they not see that, on this principle, they must pay a man not in proportion to the value of his labour but in proportion to the size of his family—that they must pay the decrepit and imbecile married man with ten children at least 2 [shillings] per day, while the able, diligent, frugal, and fore-looking bachelor may be put off 4 [pence] or 6 [pence]? Do they not see that to do this would be to

> stimulate every man to marry and to populate as fast as he could, like a rabbit in a warren—in other words that to apply this to Ireland would be to give brandy to a man lying dead drunk in a ditch?[55]

To put it bluntly, as *The Economist* did in 1846, "they have been kept at home and taught to rely more than ever on others and less than ever on themselves." Rather than be tempted by such policy, Ireland's colonists should adhere "to the principles which have been deduced from many facts by scientific men and confirmed by experience."[56] Suffering was the stimulus the poor needed to enter the labor market. Any attempt by the government to interfere with the laws of laissez-faire would merely prolong the economic injury, rather than allowing it to heal.

The same liberal economics that plagued the Irish also harmed the Silesian colonial subjects. The Silesian textile industry was in steep decline and got no support from the Prussian Empire, despite a workers' uprising in 1845.[57] The convergence of an El Niño cycle, which disrupted weather patterns,[58] incubated crop diseases and drove up food prices across the continent, combined to expose deeply entrenched inequities between the German-speaking elite and the Polish periphery of Prussian society —a political, social, and economic system that made the famine possible.[59] When Virchow returned to Berlin that spring, he found a world on fire. The city was one of several across Europe where the urban poor had reached a breaking point. Decades of political organizing had raised workers' hopes and expectations, so when the combination of climate shock and disease precipitated a global food price spike, they were ready to take to the streets.[60]

Throughout Europe, states crushed the Revolutions of 1848. Virchow himself was exiled from his post at the Charité Hospital for his participation in the uprising.[61] And while in his later years he might have resigned himself to the counterrevolution,[62] his biological research would continue to be animated by ideas of action and reaction, justice and exploitation, belonging and betrayal. He hypothesized that infectious diseases like tuberculosis and typhus were caused not by the bacterium itself but by the body's reaction to the bacterium. He also speculated that because the cells of different people reacted in different ways, the diseases presented with varied expressions. Virchow believed that social conditions more than anything else primed the body for these expressions: oppression would lead to more pronounced manifestations of disease, and justice would enable healing.[63]

Given his deep commitments to equality, Virchow was suspicious of racial categorizations and the hierarchies of supremacy they supported. At the dawn of the German nation-state, the political right championed scientific racism under the banner of Darwinism. This is why Virchow was a fierce anti-Darwinian.[64] In a bid to disprove the scientific racism of the 1870s, he oversaw a study of 6,758,827 German schoolchildren, which measured the skull sizes of Jews and Aryans and showed that there was no such thing as a pure German race.[65] (The Nazis would attack his work decades later.) But Darwin continued to cast a shadow over the study of the body's defenses, including the question of how the body knows to muster a defense in the first place. In the conclusion of his epochal book *On the Origin of the Species by Means of Natural Selection, or the Preservation of Favoured Races in the Struggle for Life*, he summarized the process of natural selection like this: "from the war of nature, from famine and death, the most exalted object which we are capable of conceiving, namely, the production of the higher animals, directly follows."[66]

When we think of the immune system, most of us think of war: our bodies defending against and destroying a foreign invader. It's a startling, even unsettling militaristic image—one that can be traced from Darwin to a Russian scientist who attacked a starfish with a rose thorn.

METCHNIKOFF AND THE MACROPHAGE

In his autobiography, Ilya (Élie in translation) Metchnikoff, the Russian zoologist whose inquiries were foundational to modern immunology, recalls a fateful day in 1881:

> When the whole family had gone to a circus to see some extraordinary performing apes, I remained alone with my microscope, observing the life in the mobile cells of a transparent star-fish larva, when a new thought suddenly flashed across my brain. It struck me that similar cells might serve in the defense of the organism against intruders.... I said to myself that if my

she asked, "Why has no animal ever mimicked a skunk?"[102] Taken with the originality of the question, one of the professors encouraged her to become a scientist.[103]

In an interview with *The New York Times*, she shared her experience in graduate school:

> We learned that the immune system fights anything that isn't part of our bodies. But that didn't make sense to me. I wondered why mothers didn't reject their fetuses, why we didn't reject the food we eat, or the stuff in the air we breathe. But my professors all said, "Don't worry about it."
>
> So I stopped worrying. This is a cowardly habit that we scientists can fall into. If we really can't answer a question, we sometimes stop asking it.[104]

Early in her career, she wrote seminal papers that were so innovative, she knew she would not be taken seriously as a young woman publishing solo. So she arranged for some of her early papers to be coauthored by her colleague Galadriel Mirkwood—her dog.[105] Within a decade of finishing grad school, she was working at the National Institutes of Health, asking that question about identity and rejection once again. Her research pushed up against the "sheer number of things to which we must be tolerant—all the potential peptides made by 55,000 different bodily proteins, plus more than 1012 potentially different B and T cell idiotypes—while maintaining the ability to respond to foreign antigens."[106]

Matzinger challenged the idea that the human body is as interested in "the self" as nineteenth-century liberalism was. It is a dynamic assembly of many different species, from our own cells to the millions of organisms who live on and inside us, whose presence is critical for development and health. The "self" of immunology is more porous and fluid than the one in liberal political science, able to be shaped by social, economic, and political injustices. Matzinger herself wrote, "The immune system does not care about self and non-self[;] its primary driving force is the need to detect and protect against danger."[107] In other words, it is "more concerned with damage than foreignness."[108]

But just as Metchnikoff's work was informed by the prevailing imperial politics and metaphors of his time, Matzinger's work drew on the social and political cosmologies of the post–Cold War United States, which included the rise of neoliberalism and its updated attitudes toward social control. She invited readers to

> imagine a community in which the police accept anyone they met during elementary school and kill any new migrant. That's the Self/Nonself Model [of immunity].
>
> In the Danger Model, tourists and immigrants are accepted, until they start breaking windows. Only then do the police move to eliminate them. In fact, it doesn't matter if the window breaker is a foreigner or a member of the community. That kind of behavior is considered unacceptable, and the destructive individual is removed.
>
> The community police are the white blood cells of the immune system.[109]

Like Metchnikoff's and Virchow's analogies, Matzinger uses ideas about the police in the body politic, another unfortunate example of how colonial carceral logic seeps into modern medicine. But her analogy describes a very different conception of police function, reflecting a new social order that preaches tolerance and moves us away from the citizen-foreigner dichotomy. In the "broken windows" theory of policing, it is the presence of *disorder*—a broken window that remains unfixed in a low-income neighborhood—that is equated with danger. Likewise in the Danger Model, only entities causing or threatening actual harm in the body trigger the immune response.[110]

Matzinger agreed with her predecessors that the immune response is complex, contextual, and multifactorial. Where she differed was in her identification of the triggers. Therein lies the explanatory power of her model. She found that the immune response "is called into action by alarm signals from injured tissues, rather than by the recognition of nonself."[111] A damaged cell will release damage-associated molecular patterns triggering inflammation.[112] For example, an abundance of uric acid, a highly inflammatory molecule produced by cellular damage, creates the clinical syndrome known as gout. Phagocytes that bridge the innate and adaptive immune systems take up these alarm signals and present them to T cells to activate a further, more engulfing inflammatory immune response.

The Danger Model also describes how a nonself entity, such as a virus, can become a beneficial agent of transformation for the self. Cells have developed mechanisms to resist viruses, but there are


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This is a work of nonfiction. Some names and details have, however, been changed, primarily to protect patient privacy.