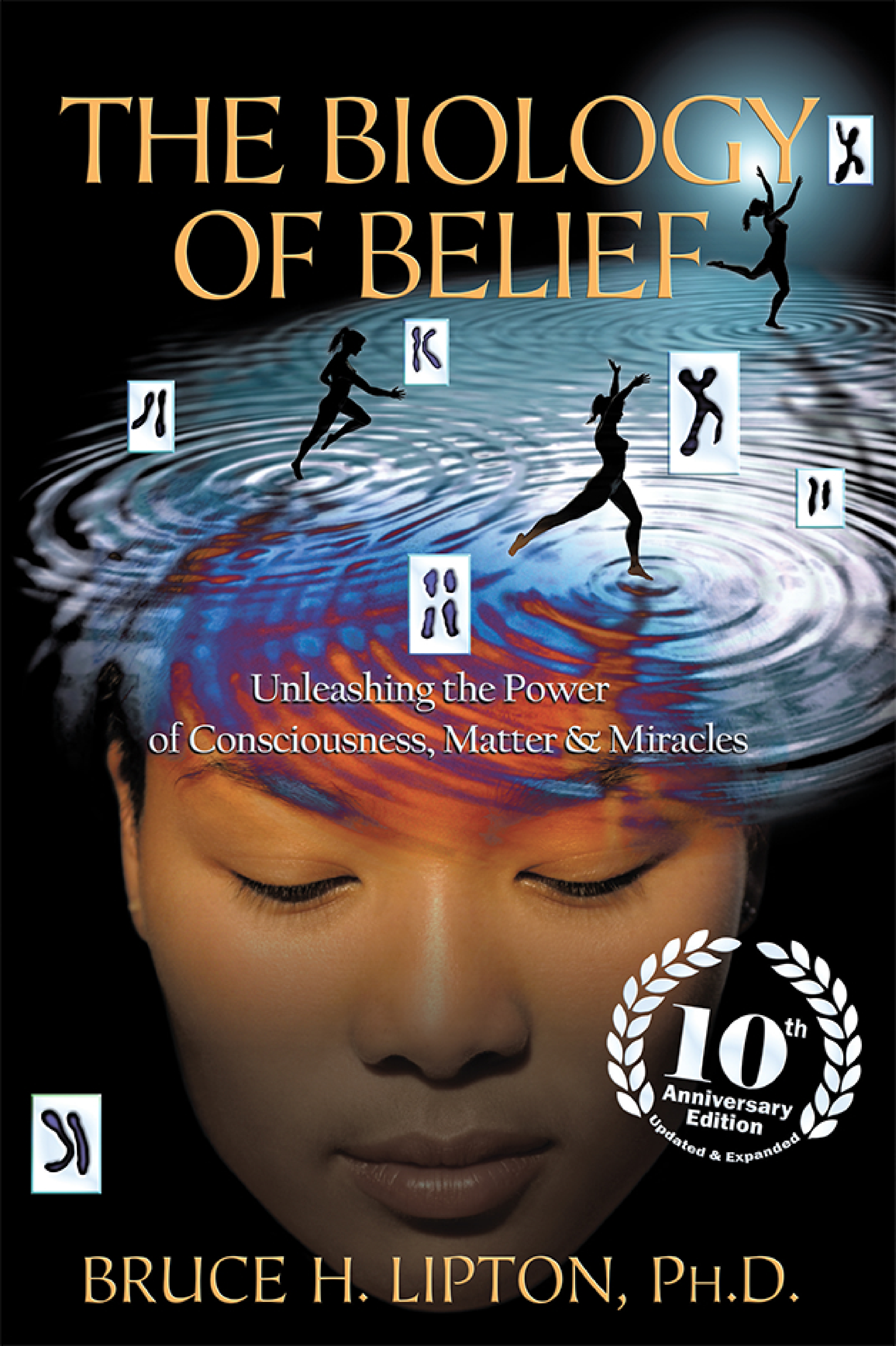

THE BIOLOGY OF BELIEF

Unleashing the Power of Consciousness, Matter & Miracles

10th Anniversary Edition
Updated & Expanded

BRUCE H. LIPTON, PH.D.

Praise for *The Biology of Belief*

"Bruce Lipton's book is the definitive summary of the new biology and all it implies. It is magnificent, profound beyond words, and a delight to read. It synthesizes an encyclopedia of critical new information into a brilliant yet simple package. These pages contain a genuine revolution in thought and understanding, one so radical that it can change the world."

— Joseph Chilton Pearce, Ph.D.,
author of *Magical Child* and *Evolution's End*

"Bruce Lipton's delightfully written *The Biology of Belief* is a much needed antidote to the 'bottom-up' materialism of today's society. The idea that DNA encodes all of life's development is being successfully employed in genetic engineering. At the same time, the shortfall of this approach is becoming evident. *The Biology of Belief* is a review of a quarter-century of pioneering results in Epigenetics, heralded by *The Wall Street Science Journal* in mid-2004 as an important new field. Its personal style makes it eminently readable and enjoyable."

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"Dr. Lipton is a genius. His breakthrough discoveries give us tools for regaining the sovereignty over our lives. I recommend this book to anyone who is ready and willing to take full responsibility for themselves and the destiny of our planet."

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"Bruce Lipton offers new insights and understanding into the interface between biological organisms, the environment—and the influence of thought, perception, and subconscious awareness—on the expression of one's body healing potential. Well-referenced explanations and examples make this book a refreshing 'must read' for the student of the biological, social, and health care sciences.

Yet the clarity of the author's presentation makes it an enjoyable read for a general audience."

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"In this paradigm-busting book, Bruce Lipton delivers a TKO to Old Biology. With a left to Darwinian dogma and a right to allopathic medicine, he breaks out of the physicalist box into enlightenment on the mind/body (belief/biology) system. Must read, much fun."

— Ralph Abraham, Ph.D., professor of mathematics,
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— Gregg Braden,
best-selling author of *The God Code* and *The Divine Matrix*

"I finished reading this book with the same sense of profound respect I have when I am with Bruce Lipton—that I have been touched by a revolutionary sense of the truth. He is both a scientist and a philosopher; a scientist in that he provides us with tools to alter cultural consciousness and a philosopher because he challenges our beliefs about the very nature of our perceived reality. He is helping us create our own futures."

— Guy F. Riekeman, D.C.,
President, Life University and College of Chiropractic

"*The Biology of Belief* is a milestone for evolving humanity. Dr. Bruce Lipton has provided, through his amazing research and in this inspiring book, a new, more awakened science of human growth and transformation. Instead of being limited by the genetic or biological constraints that humanity has been programmed to live by, humanity now has before it a way of unleashing its true spiritual potential with the help of simply transformed beliefs guided by 'the gentle and loving hand of God.' A definite must read for those dedicated to the mind/body movement and to the true essence of healing."

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"Finally, a compelling and easy-to-understand explanation of how your emotions regulate your genetic expression! You need to read this book to truly appreciate that you are not a victim of your genes but instead have unlimited capacity to live a life overflowing with peace, happiness, and love."

— Joseph Mercola, D.O., Founder of **www.mercola.com**, world's most visited natural-health site

"This book is an absolute must read if you want to know, from a scientific viewpoint, that your lifestyle is in control of your health rather than your genetics. From a scientific viewpoint, Lipton demonstrates that the mind is more powerful than drugs to regain our health. The information reveals that your health is more your responsibility than just being a victim of your genes. When I started reading this book, I could not stop until it was finished."

— M. T. Morter, Jr., D.C., founder, Morter Health System; developer of the B.E.S.T. Technique

"This is a courageous and visionary book that provides solid evidence from quantum biology to dispel the myth of genetic determinism—and implicitly, victimhood. Dr. Bruce Lipton brings a solid scientific mind to not only inform but to transform and empower the reader with the realization that our beliefs create every aspect of our personal reality. A provocative and inspiring read!"

— Lee Pulos, Ph.D., A.B.P.P.,
professor emeritus, University of British Columbia;
author of *Miracles and Other Realities* and *Beyond Hypnosis*

"History will record *The Biology of Belief* as one of the most important writings of our time. Bruce Lipton has delivered the missing link between the understandings of biomedicine of the past and the essentials of energetic healing of the future. His complex insights are expressed in a readily understandable fashion with a style that welcomes the scientist and the nonscientist on an equal footing. For anyone interested in health, the well-being of the species, and the future of human life, *The Biology of Belief* is a must read. The implications of the perspectives outlined have the potential to change the world as we know it. Bruce Lipton's understandings—and his concise expression of them—are sheer genius."

— Gerard W. Clum, D.C.,
President, Life Chiropractic College West

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Unleashing the Power of Consciousness, Matter & Miracles

Bruce H. Lipton, Ph.D.

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This book is dedicated to . . .

The Mother of Us All
May She forgive us our trespasses.

To my own mother, Gladys,
who has continually encouraged and supported me
while being patient for the twenty years
it took to get this book out.

To my daughters, Tanya and Jennifer,
beautiful women of the world who have always been there
for me . . . no matter how weird things had become.

And especially to my darling, Margaret Horton,
my best friend, my life partner, my love.
May we continue on our joyous quest
to live happily ever after!

Contents

Chapter 1

LESSONS FROM THE PETRI DISH:

In Praise of Smart Cells and Smart Students

On my second day in the Caribbean, as I stood in front of more than a hundred visibly on-edge medical students, I suddenly realized that not everyone viewed the island as a laid-back refuge. For these nervous students, Montserrat was not a peaceful escape but a last-ditch chance to realize their dreams of becoming doctors.

My class was geographically homogeneous, mostly American students from the East Coast, but there were all races and ages, including a sixty-seven-year-old retiree who was anxious to do more with his life. Their backgrounds were equally varied—former elementary school teachers, accountants, musicians, a nun, and even a drug smuggler.

Despite all the differences, the students shared two characteristics: One, they had failed to succeed in the highly competitive selection process that filled the limited number of positions in American medical schools. Two, they were "strivers" intent on becoming doctors—they were not about to be denied the opportunity to prove their qualifications. Most had spent their life savings or indentured themselves to cover the tuition and extra costs of living out of the country. Many found themselves completely alone for the first time in their lives, having left their families, friends, and loved ones behind. They put up with the most intolerable living conditions on that campus. Yet with all the drawbacks and the odds stacked against them, they were never deterred from their quest for a medical degree.

Well, at least that was true up to the time of our first class together. Prior to my arrival, the students had had three different histology/cell biology professors. The first lecturer left the students in the lurch when he responded to some personal issue by bolting from the island three weeks into the semester. In short order, the school found a suitable replacement who tried to pick up the pieces; unfortunately he bailed three weeks later because he got sick. For the preceding two weeks, a faculty member, responsible for another field of study, had been reading chapters out of a textbook to the class. This obviously bored the students to death, but the school was fulfilling a directive to provide a specified number of lecture hours for the course. Academic prerequisites set by American medical examiners have to be met in order for the school's graduates to practice in the States.

For the fourth time that semester, the weary students listened to a new professor. I briefed them on my background and my expectations for the course. I made it clear that even though we were in a foreign country, I was not going to expect any less from them than what was expected from my Wisconsin students. Nor should they want me to because to be certified all doctors have to pass the same Medical Boards, no matter where they go to medical school. Then I pulled a sheaf of exams out of my briefcase and told the students that I was giving them a self-assessment quiz. The middle of the semester had just passed, and I expected them to be familiar with half of the required course material. The test I handed out on that first day of the course consisted of twenty questions taken directly from the University of Wisconsin histology midterm exam.

The classroom was deadly silent for the first ten minutes of the testing period. Then nervous fidgeting felled the students one by one, faster than the spread of the deadly Ebola virus. By the time the twenty minutes allotted for the quiz were over, wide-eyed panic had gripped the class. When I said, "Stop," the pent-up nervous anxiety erupted into the din of a hundred excited conversations. I quieted the class down and began to read them the answers. The first five or six answers were met with subdued sighs. After I reached the tenth question, each subsequent answer was followed by agonizing groans. The highest score in the class was ten correct answers, followed by several students who answered seven correctly; with guesswork, most of the rest scored at least one or two correct answers.

When I looked up at the class, I was greeted with frozen, shell-shocked faces. The "strivers" found themselves behind the big eight ball. With more than half a semester behind them, they had to start the course all over again. A dark gloom overcame the students, most of whom were already treading water in their other, very demanding medical school courses. Within moments, their gloom had turned into quiet despair. In profound silence, I looked out over the students and they looked back at me. I experienced an internal ache—the class collectively resembled one of those Greenpeace pictures of wide-eyed baby seals just before heartless fur traders club them to death.

My heart welled. Perhaps the salt air and sweet scents had already made me more magnanimous. In any case, unexpectedly, I found myself announcing that I would make it my personal commitment to see that every student was fully prepared for the final exam, if they would commit to providing matching efforts. When they realized I was truly committed to their success, I could see the lights flash on in their previously panicked eyes.

Feeling like an embattled coach revving up the team for the Big Game, I told them I thought they were every bit as intelligent as the students I taught in the States. I told them I believed their stateside peers were simply more proficient at rote memorization, the quality that enabled them to score better in the medical college admissions tests. I also tried very hard to convince them that histology and cell biology are not intellectually difficult courses. I explained that in all of its elegance, nature employs very simple operating principles. Rather than just memorizing facts and figures, I promised they were going to gain an understanding of cells because I would present simple principles on top of simple principles. I offered to provide additional night lectures, which would tax their stamina after their already long lecture- and lab-packed days. The students were pumped up after my ten-minute pep talk. When the period ended, they bolted from that classroom snorting fire, determined they would not be beaten by the system.

After the students left, the enormity of the commitment I had made sank in. I started having doubts. I knew that a significant number of the students were truly unqualified to be attending medical school. Many others were capable students whose backgrounds had not prepared them for the challenge. I was afraid that my island idyll would degenerate into a frenetic, time-consuming academic scrimmage that would end in failure for my students and for me as their teacher. I started thinking about my job at Wisconsin, and suddenly it was beginning to look easy. At Wisconsin, I gave only eight lectures out of the approximately fifty that made up the histology/cell biology course. There were five members of the anatomy department who shared the lecturing load. Of course I was responsible for the material in all of the lectures because I was involved in their accompanying laboratory sessions. I was supposed to be available to answer all course-related questions asked by the students. But knowing the material and presenting lectures on the material are not the same thing!

I had a three-day weekend to wrestle with the situation I had created for myself. Had I faced a crisis such as this back home, my type A personality would have had me swinging from the proverbial chandeliers. Interestingly, as I sat by the pool, watching the sun set into the Caribbean, the potential angst simply morphed into an exciting adventure. I began to get excited about the fact that for the first time in my teaching career, I was solely responsible for this major course and free from having to conform to the style and content restrictions of team-taught programs.

Cells as Miniature Humans

As it turned out, that histology course was the most exhilarating and intellectually profound period of my academic career. Free to teach the course the way I wanted to teach it, I ventured into a new way of covering the material, an approach that had been roiling in my brain for several years. I had been fascinated by the idea that considering cells as "miniature humans" would make it easier to understand their physiology and behavior. As I contemplated a new structure for the course, I got excited. The idea of overlapping cell and human biology rekindled the inspiration for science I had felt as a child. I still experienced that enthusiasm in my research laboratory, though not when I was mired in the administrative details of being a tenured faculty member, including endless meetings and what, for me, were torturous faculty parties.

I was prone to thinking of cells as human-like because, after years behind a microscope, I had become humbled by the complexity and power of what at first appear to be anatomically simple, moving blobs in a petri dish. In school you may have learned the basic components of a cell: the nucleus that contains genetic material, the energy-producing mitochondria, the protective membrane at the outside rim, and the cytoplasm in between. But within these anatomically simple–looking cells is a complex world; these smart cells employ technologies that scientists have yet to fully fathom.

The notion of cells as miniature humans that I was mulling over would be considered heresy by most biologists. Trying to explain the nature of anything not human by relating it to human behavior is called anthropomorphism. "True" scientists consider anthropomorphism to be something of a mortal sin and ostracize scientists who knowingly employ it in their work.

However, I believed that I was breaking out of orthodoxy for a good reason. Biologists try to gain scientific understanding by observing nature and conjuring up a hypothesis of how things work. Then they design experiments to test their ideas. By necessity, deriving the hypothesis and designing the experiments require the scientist to "think" how a cell or another living organism carries out its life. Applying these "human" solutions, i.e., a human view of resolving biology's mysteries, automatically makes these scientists guilty of anthropomorphizing. No matter how you cut it, biological science is based to some degree on humanizing the subject matter.

Actually, I believe that the unwritten ban on anthropomorphism is an outmoded remnant of the Dark Ages, when religious authorities denied any direct relationship existed between humans and any of God's other creations. While I can see the value of the concept when people try to anthropomorphize a lightbulb, a radio, or a pocketknife, I do not see it as a valid criticism when it is applied to living organisms. Human beings are multicellular organisms—we must inherently share basic behavioral patterns with our own cells.

However, I know that it takes a shift in perception to acknowledge that parallel. Historically, our Judeo-Christian beliefs have led us to think that *we* are the intelligent creatures who were created in a separate and distinct process from all other plants and animals. This view has us looking down our noses at lesser creatures as nonintelligent life forms, especially those organisms on the lower evolutionary rungs of life.

Nothing could be further from the truth. When we observe other humans as individual entities or see ourselves in the mirror as an individual organism, in one sense, we are correct, at least from the perspective of our level of observation. However, if I brought you down to the size of an individual cell so you could see your body from that perspective, it would offer a whole new view of the world. When you looked back at yourself from that perspective you would not see yourself as a single entity. You would see yourself as a bustling community of more than 50 trillion individual cells.

As I toyed with these ideas for my histology class, the picture that kept recurring in my mind was a chart from an encyclopedia I had used as a child. Under the section on humans, there was an illustration with seven transparent plastic pages, each printed with an identical, overlapping outline of the human body. On the first page the outline was filled in with an image of a naked man. Turning the first page was like peeling off his skin and revealing his musculature, the image within the outline on the second page. When I turned the second page, the overlapping images of the remaining pages revealed a vivid dissection of the body. Flipping through the pages I could see in turn, the skeleton, the brain and nerves, blood vessels, and organ systems.

For my Caribbean course, I mentally updated those transparencies with several additional, overlapping pages, each illustrated with cellular structures. Most of the cell's structures are referred to as organelles, which are its "miniature organs" suspended within a jelly-like cytoplasm. Organelles are the functional equivalents of the tissues and organs of our own bodies. They include the nucleus, which is the largest organelle, the mitochondria, the Golgi body, and vacuoles. The traditional way of teaching the course is to deal first with these cellular structures, then move on to the tissues and organs of the human body. Instead, I integrated the two parts of the course to reflect the overlapping nature of humans and cells.

I taught my students that the biochemical mechanisms employed by cellular organelle systems are essentially the same mechanisms employed by our human organ systems. Even though humans are made up of trillions of cells, I stressed that there is not one "new" function in our bodies that is not already expressed in the single cell. Virtually every eukaryote (nucleus-containing cell) possesses the functional equivalent of our nervous system, digestive system, respiratory system, excretory system, endocrine system, muscle and skeletal systems, circulatory system, integument (skin), reproductive system, and even a primitive immune system, which utilizes a family of antibody-like "ubiquitin" proteins.

I also made it clear to my students that each cell is an intelligent being that can survive on its own, as scientists demonstrate when they remove individual cells from the body and grow them in a culture. As I knew intuitively when I was a child, these smart cells are imbued with intent and purpose; they actively seek environments that support their survival while simultaneously avoiding toxic or hostile ones. Like humans, single cells analyze thousands of stimuli from the microenvironment they inhabit. Through the analysis of this data, cells select appropriate behavioral responses to ensure their survival.

Single cells are also capable of learning through these environmental experiences and are able to create cellular memories, which they pass on to their offspring. For example, when a measles virus infects a child, an immature immune cell is called in to create a protective protein antibody against that virus. In the process, the cell must create a new gene to serve as a blueprint in manufacturing the measles antibody protein.

The first step in generating a specific measles antibody gene occurs in the nuclei of immature immune cells. Among their genes are a very large number of DNA segments that encode uniquely shaped snippets of proteins. By randomly assembling and recombining these DNA segments, immune cells create a vast array of different genes, each one providing for a uniquely shaped antibody protein. When an immature immune cell produces an antibody protein that is a "close" physical complement to the invading measles virus, that cell will be activated.

Activated cells employ an amazing mechanism called *affinity maturation* that enables the cell to perfectly "adjust" the final shape of its antibody protein, so that it will become a perfect complement to the invading measles virus. (Li, et al, 2003; Adams, et al, 2003) Using a process called *somatic hypermutation,* activated immune cells make hundreds of copies of their original antibody gene. However, each new version of the gene is slightly mutated so that it will encode a slightly different shaped antibody protein. The cell selects the variant gene that makes the best-fitting antibody. This selected version of the gene also goes through repeated rounds of somatic hypermutation to further sculpt the shape of the antibody to become a "perfect" physical complement of the measles virus. (Wu, et al, 2003; Blanden and Steele 1998; Diaz and Casali 2002; Gearhart 2002)

When the sculptured antibody locks on to the virus, it inactivates the invader and marks it for destruction, thus protecting the child from the ravages of measles. The cells retain the genetic "memory" of this antibody, so that in the future if the individual is again exposed to measles, the cells can immediately launch a protective immune response. The new antibody gene can also be passed on to all the cell's progeny when it divides. In this process, not only did the cell "learn" about the measles virus, it also created a "memory" that will be inherited and propagated by its daughter cells. This amazing feat of genetic engineering is profoundly important because it represents an inherent "intelligence" mechanism by which cells evolve. (Steele, et al, 1998)

The Origins of Life: Smart Cells Get Smarter

It shouldn't be surprising that cells are so smart. Single-celled organisms were the first life forms on this planet. Fossil evidence reveals they were here within 600 million years after the Earth was first formed. For the next 2.75 billion years of the Earth's history, only free-living, single-celled organisms—bacteria, algae, and amoeba-like protozoans—populated the world.

Around 750 million years ago, these smart cells figured out how to get smarter when the first multicellular organisms (plants and animals) appeared. Multicellular life forms were initially loose communities or "colonies" of single-celled organisms. At first, cellular communities consisted of from tens to hundreds of cells. But the evolutionary advantage of living in a community soon led to organizations comprised of millions, billions, and even trillions of socially interactive single cells. Though each individual cell is of microscopic dimensions, the size of multicellular communities may range from the barely visible to the monolithic. Biologists have classified these organized communities based on their structure as observed by the human eye. While the cellular communities appear as single entities to the naked eye—a mouse, a dog, a human—they are, in fact, highly organized associations of millions and trillions of cells.

The evolutionary push for ever-bigger communities is simply a reflection of the biological imperative to survive. The more awareness an organism has of its environment, the better its chances for survival. When cells band together they increase their awareness exponentially. If each cell were to be arbitrarily assigned an awareness value of X, then each colonial organism would collectively have a potential awareness value of at least X times the number of cells in the colony.

In order to survive at such high densities, the cells created structured environments. These sophisticated communities subdivided the workload with more precision and effectiveness than the ever-changing organizational charts that are a fact of life in big corporations. It proved more efficient for the community to have individual cells assigned to specialized tasks. In the development of animals and plants, cells begin to acquire these specialized functions in the embryo. A process of cytological specialization enables the cells to form the specific tissues and organs of the body. Over time, this pattern of *differentiation*, i.e., the distribution of the workload among the members of the community, became embedded in the genes of every cell in the community, significantly increasing the organism's efficiency and its ability to survive.

In larger organisms, for example, only a small percentage of cells are concerned with reading and responding to environmental stimuli. That is the role of groups of specialized cells that form the tissues and organs of the nervous system. The function of the nervous system is to perceive the environment and coordinate the behavior of all the other cells in the vast cellular community.

Division of labor among the cells in the community offered an additional survival advantage. The efficiency it offered enabled more cells to live on less. Consider the old adage: "Two can live as cheaply as one." Or consider the construction costs of building a two-bedroom single home versus the cost of building a two-bedroom apartment in a hundred-apartment complex. To survive, each cell is required to expend a certain amount of energy. The amount of energy conserved by individuals living in a community contributes to both an increased survival advantage and a better quality of life.

In American capitalism, Henry Ford saw the tactical advantage in the differentiated form of communal effort and employed it in creating his assembly line system of manufacturing cars. Before Ford, a small team of multiskilled workers would require a week or two to build a single automobile. Ford organized his shop so that every worker was responsible for only one specialized job. He stationed a large number of these differentiated workers along a single row, the assembly line, and passed the developing car from one specialist to the next. The efficiency of job specialization enabled Ford to produce a new automobile in ninety minutes rather than weeks.

Unfortunately, we conveniently "forgot" about the cooperation necessary for evolution when Charles Darwin emphasized a radically different theory about the emergence of life. He concluded 150 years ago that living organisms are perpetually embroiled in a "struggle for existence." For Darwin, struggle and violence are not only a part of animal (human) nature but the principal "forces" behind evolutionary advancement. In the final chapter of *The Origin of Species: By Means of Natural Selection, Or, the Preservation of Favoured Races in the Struggle for Life,* Darwin wrote of an inevitable "struggle for life" and that evolution was driven by "the war of nature, from famine and death." Couple that with Darwin's notion that evolution is random and you have a world, as poetically described by Tennyson, that can be characterized as "red in tooth and claw," a series of meaningless, bloody battles for survival.

Evolution Without the Bloody Claws

Though Darwin is by far the most famous evolutionist, the first scientist to establish evolution as a scientific fact was the distinguished French biologist Jean-Baptiste Lamarck. (Lamarck 1809, 1914, 1963) Even Ernst Mayr, the leading architect of "neo-Darwinism," a modernization of Darwin's theory that incorporates twentieth-century molecular genetics, concedes that Lamarck was the pioneer. In his classic 1970 book, *Evolution and the Diversity of Life,* (Mayr 1976, page 227) Mayr wrote: "It seems to me Lamarck has a much better claim to be designated the 'founder of the theory of evolution,' as indeed he has by several French historians . . . he was the first author to devote an entire book primarily to the presentation of a theory of organic evolution. He was the first to present the entire system of animals as a product of evolution."

Not only did Lamarck present his theory fifty years before Darwin, he offered a much less harsh theory of the mechanisms of evolution. Lamarck's theory suggested that evolution was based on an "instructive," cooperative interaction among organisms and their environment that enables life forms to survive and evolve in a dynamic world. His notion was that organisms acquire and pass on adaptations necessary for their survival in a changing environment. Interestingly, Lamarck's hypothesis about the mechanisms of evolution conform to modern cell biologists' understanding of how immune systems adapt to their environment as described above.

Lamarck's theory was an early target of the Church. The notion that humans evolved from lower life forms was denounced as heresy. Lamarck was also scorned by his fellow scientists who, as creationists, ridiculed his theories. A German developmental biologist, August Weismann, helped propel Lamarck into obscurity when he tried to test Lamarck's theory that organisms pass on survival-oriented traits acquired through their interaction with the environment. In one of Weismann's experiments, he cut off the tails of male and female mice and mated them. Weismann argued that if Lamarck's theory were correct, the parents should pass on their tail-less state to future generations. The first generation of mice was born with tails. Weismann repeated the experiment for twenty-one more generations, but not one tail-less mouse was born, leading Weismann to conclude that Lamarck's notion of inheritance was wrong.

But Weismann's experiment was not a true test of Lamarck's theory. Lamarck suggested that such evolutionary changes could take "immense periods of time," according to biographer L. J. Jordanova. In 1984, Jordanova wrote that Lamarck's theory "rested on" a number of "propositions" including "the laws governing living things have produced increasingly complex forms over immense periods of time." (Jordanova 1984, page 71) Weismann's five-year experiment was clearly not long enough to test the theory. An even more fundamental flaw in his experiment is that Lamarck never argued that every change an organism experienced would take hold. Lamarck said organisms hang on to traits (like tails) when they need them to survive. Although Weismann didn't think the mice needed their tails, no one asked the mice if they thought their tails were necessary for survival!

Despite its obvious flaws, the study of the tail-less mice helped destroy Lamarck's reputation. In fact, Lamarck has been mostly ignored or vilified. Cornell University evolutionist C. H. Waddington wrote in *The Evolution of an Evolutionist* (Waddington 1975, page 38): "Lamarck is the only major figure in the history of biology whose name has become to all intents and purposes, a term of abuse. Most scientists' contributions are fated to be outgrown, but very few authors have written works, which, two centuries later, are still rejected with indignation so intense that the skeptic may suspect something akin to an uneasy conscience. In point of fact, Lamarck has, I think, been somewhat unfairly judged."

Waddington wrote those prescient words thirty-five years ago. Today Lamarck's theories are being re-evaluated under the weight of a body of new science that suggests that the oft-denounced biologist was not entirely wrong and the oft-lauded Darwin not entirely correct. The title of an article in the prestigious journal *Science* in 2000 was one sign of glasnost: "Was Lamarck Just a Little Bit Right?" (Balter 2000)

One reason some scientists are taking another look at Lamarck is that evolutionists are reminding us of the invaluable role cooperation plays in sustaining life in the biosphere. Scientists have long noted symbiotic relationships in nature. In *Darwin's Blind Spot* (Ryan 2002, page 16), British physician Frank Ryan chronicles a number of such relationships, including a yellow shrimp that gathers food while its partner gobi fish protects it from predators and a species of hermit crab that carries a pink anemone on top of its shell. "Fish and octopuses like to feed on hermit crabs, but when they approach this species, the anemone shoots out its brilliantly colored tentacles, with their microscopic batteries of poisoned darts, and stings the potential predator, encouraging it to look elsewhere for its meal." The warrior anemone gets something out of the relationship as well because it eats the crab's leftover food.

But today's understanding of cooperation in nature goes much deeper than the easily observable relationships. "Biologists are becoming increasingly aware that animals have coevolved and continue to coexist, with diverse assemblages of microorganisms that are required for normal health and development," according to a recent article in *Science* called "We Get By with a Little Help from Our (Little) Friends." (Ruby, et al, 2004) The study of these relationships is now a rapidly growing field called "Systems Biology."

Ironically, in recent decades, we have been taught to wage war against microorganisms with everything from antibacterial soap to antibiotics. But that simplistic message ignores the fact that many bacteria are essential to our health. The classic example of how humans get help from microorganisms is the bacteria in our digestive system, which are essential to our survival. The bacteria in our stomach and intestinal tract help digest food and also enable the absorption of life-sustaining vitamins. This microbe-human cooperation is the reason that the rampant use of antibiotics is detrimental to our survival. Antibiotics are indiscriminate killers; they kill bacteria that are required for our survival as efficiently as they kill harmful bacteria.

Recent advances in genome science have revealed an additional mechanism of cooperation among species. Living organisms, it turns out, actually integrate their cellular communities by sharing their genes. It had been thought that genes are passed on only to the progeny of an individual organism through reproduction. Now scientists realize that genes are shared not only among the individual members of a species but also among members of different species. The sharing of genetic information via *gene transfer* speeds up evolution since organisms can acquire "learned" experiences from other organisms. (Nitz, et al, 2004; Pennisi 2004; Boucher, et al, 2003; Dutta and Pan 2002; Gogarten 2003) Given this sharing of genes, organisms can no longer be seen as disconnected entities; there is no wall between species. Daniel Drell, manager of the Department of Energy's microbial genome program told *Science* (2001 294:1634) "we can no longer comfortably say what is a species anymore." (Pennisi 2001)

This sharing of information is not an accident. It is nature's method of enhancing the survival of the biosphere. As discussed earlier, genes are physical memories of an organism's learned experiences. The recently recognized exchange of genes among individuals disperses those memories, thereby influencing the survival of all organisms that make up the community of life. Now that we are aware of this inter- and intra-species gene transfer mechanism, the dangers of genetic engineering become apparent. For example, tinkering with the genes of a tomato may not stop at that tomato but could alter the entire biosphere in ways that we cannot foresee. Already there is a study that shows that when humans digest genetically modified foods, the artificially created genes transfer into and alter the character of the beneficial bacteria in the intestine. (Heritage 2004; Netherwood, et al, 2004) Similarly, gene transfer among genetically engineered agricultural crops and surrounding native species has given rise to highly resistant species deemed superweeds. (Milius 2003; Haygood, et al, 2003; Desplanque, et al, 2002; Spencer and Snow 2001) Genetic engineers have never taken the reality of gene transfer into consideration when they have introduced genetically modified organisms into the environment. We are now beginning to experience the dire consequences of this oversight as their engineered genes are spreading among and altering other organisms in the environment. (Watrud, et al, 2004; Biello 2010)

Genetic evolutionists warn that if we fail to apply the lessons of our shared genetic destiny, which should be teaching us the importance of cooperation among all species, we threaten human existence. We need to move beyond Darwinian Theory, which stresses the importance of *individuals*, to one that stresses the importance of the *community.* British scientist Timothy Lenton provides evidence that evolution is more dependent on the interaction among species than it is on the interaction of individuals within a species. Evolution becomes a matter of the survival of the fittest *groups* rather than the survival of the fittest individuals. In a 1998 article in *Nature,* Lenton wrote that rather than focusing on individuals and their role in evolution "we must consider the totality of organisms and their material environment to fully understand which traits come to persist and dominate." (Lenton 1998)

Lenton subscribes to James Lovelock's Gaia hypothesis that holds that the Earth and all of its species constitute one interactive, living organism. Those who endorse this hypothesis argue that tampering with the balance of the superorganism called Gaia, whether it be by destroying the rainforest, depleting the ozone layer, or altering organisms through genetic engineering, can threaten its survival and consequently ours.

Recent studies funded by Britain's Natural Environment Research Council provide support for those concerns. (Thomas, et al, 2004; Stevens, et al, 2004) While there have been five mass extinctions in the history of our planet, they are all presumed to have been caused by extraterrestrial events, such as a comet smashing to Earth. One of the new studies concludes that the "natural world is experiencing the sixth, major extinction event in its history." (Lovell 2004) This time though, the cause of the extinction is not extraterrestrial. According to one of the study's authors, Jeremy Thomas, "As far as we can tell this one is caused by one animal organism—man."

Walking the Talk of Cells

In my years of teaching in medical school, I had come to realize that medical students in an academic setting are more competitive and backbiting than a truckload of lawyers. They live out the Darwinian struggle in their quest to be one of the "fittest" who stagger to graduation after four grueling years in medical school. The single-minded pursuit of stellar medical school grades, without regard for the students surrounding you, no doubt follows a Darwinian model, but it always seemed to me an ironic pursuit for those who are striving to become compassionate healers.

But my stereotypes about medical students toppled during my stay on the island. After my call to arms, my class of misfits stopped acting like conventional medical students; they dropped their survival of the fittest mentality and amalgamated into a single force, a team that helped them survive the semester. The stronger students helped the weaker and, in so doing, all became stronger. Their harmony was both surprising and beautiful to observe.

In the end, there was a bonus: a happy Hollywood ending. For their final exam, I gave my students exactly the same test the students in Wisconsin had to pass. There was virtually no difference in the performance of these "rejects" and their "elite" counterparts in the States. Many students later reported that when they went home and met with their peers who attended American medical schools, they proudly found themselves more proficient in their understanding of the principles governing the life of cells and organisms.

I was of course thrilled that my students had pulled off an academic miracle. But it was years before I understood *how* they were able to do it. At the time, I thought the format of the course was key, and I still believe that overlapping human and cell biology is a better way to present the course material. But now that I've ventured into what I told you would be considered by some as wacky Dr. Dolittle territory, I think a good part of the reason for my students' success was that they eschewed the behavior of their counterparts in the United States. Instead of mirroring smart American medical students, they mirrored the behavior of smart cells, banding together to become even smarter. I didn't tell my students to pattern their lives after the lives of the cells, because I was still steeped in traditional, scientific training. But I like to think that they went in that direction intuitively after listening to my praise of cells' ability to group together cooperatively to form more complex and highly successful organisms.

I didn't know it at the time, but I now believe that another reason for my students' success was that I did not stop at praising cells. I praised the students as well. They needed to hear they were first-rate students in order to believe that they could perform as first-rate students. As I will detail in future chapters, so many of us are leading limited lives not because we have to but because we *think* we have to. But I'm getting ahead of myself. Suffice it to say that after four months in paradise, teaching in a way that clarified my thinking about cells and the lessons they provide to humans, I was well on my way to an understanding of the New Biology, which leaves in the dust the defeatism of genetic and parental programming as well as survival-of-the-fittest Darwinism.

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When I first wrote this chapter, I had to search hard for the first glimmerings that the much-maligned Jean-Baptiste Lamarck would finally be credited for his insights about evolution. Nevertheless, proverbial optimist that I am, as you read above, I included a reference to an article with the tentative headline, "Was Lamarck Just a Little Bit Right?" I'm happy to report that my optimism was warranted. A decade later, it's a lot easier to find Lamarck supporters who believe that he was more than "just a little bit" right, that, in fact, he was a seer!

Nearly 200 years after his death, epigenetic research, one of the hottest fields in science today, is corroborating over and over Lamarck's oft-ridiculed belief that organisms adapt to their environment and can pass on those adaptations to future generations. Consider this definitive (no question mark!) headline I quickly came across during my research for this anniversary edition: "The Rebirth of Lamarckism (The Rise of Epigenetics)." (Rogers 2009)

Of course, Lamarck did not have any insight into the molecular nature of genes and their relationship to organismal expression (neither did Darwin), so I can't argue that he was actually an epigeneticist. It has taken the high-tech labs of modern researchers to uncover the subtle chemical modifications to DNA and DNA-associated proteins that enable organisms to adapt to their environment and pass on those adaptations to their offspring without changing the structure of DNA molecules. Lamarck's theory of the inheritance of acquired characteristics, cited as the primary reason to debunk Lamarck, has now been found to be a valid hereditary mechanism. (Morris 2012) Frontier research is not only helping rehabilitate Lamarck's reputation, it is also undermining our culture's belief in genetic determinism, which, as you know by now, is one of the major themes of *The Biology of Belief*—the genes we inherit from our mothers and our fathers are not our fate!

I don't want to oversell the scientific community's shift to Lamarckism. When it comes to the mechanisms that drive evolution, there is still a lot of debate. For example, when the theory of "adaptive mutation," which holds that mutations occur in response to specific stresses, was first brought to academic attention in the 1980s by eminent physician and molecular biologist Dr. John Cairns, he was called a heretic, and this theory is still controversial today. (Cairns, et al, 1988) Adaptive mutation conflicts with neo-Darwinism's focus on chance alterations in heredity based on *natural selection*, a process that was described by Darwin as the "struggle for life most severe" and that came to be known as "survival of the fittest." (Though it's a catchy phrase, survival of the fittest is actually a tautology, an obvious truth that is not an apt way of describing the driving forces of evolution. By definition, *fittest* means "most capable of survival," so the phrase can be rewritten as "survival of the most capable of surviving." No argument there!)

Neo-Darwinism attributes mutations to accidental copying mistakes in replicating the genes; if the genetic error enhances the organism's survivability, the mutation is selected to propagate. This suggests that the direction of evolutionary advancement is accidental and unpredictable . . . how's that for a tautology! In response to the perennial questions "How did we get here?" and "Why are we here?" neo-Darwinian theory would lead us to believe we evolved through a few billion years of "lucky" genetic accidents. In contrast, Lamarckian theory implies that evolution-producing mutations arise from an organism's "need" to adapt to life-threatening environmental stresses, so they are not random and to a large degree are environmentally predictable.

This seemingly arcane scientific debate is important because adaptive mutations imply purposefulness in biological evolution—the purpose being to conform to prevailing conditions in the surrounding environment, which includes the entire community of life. Eventually, I believe the theory of adaptive mutations will prevail and provide more support for the view that the web of life and the process of evolution are the result of a highly organized, symbiotic *collaboration* among all living organisms.

The fascinating research of biologist and mathematician Martin A. Nowak, Director of Harvard's Program for Evolutionary Dynamics, already provides support for the crucial role of cooperation in evolution. Using mathematical and computer simulations, Nowak divided populations into "cooperators," those who support others, and "defectors," those who do not support others even after accepting help from others. Nowak found that in the several thousand papers scientists have published on how cooperators, ranging from bacteria to human beings, prevail in evolution, all the scenarios fall into five categories. (Nowak 2012)

One category, for example, is "spatial selection," in which cooperators and defectors are not uniformly distributed in a population. In these populations with "patches of cooperators," helpful individuals band together and prevail against defectors. Another category is what Nowak calls the "I'll scratch your back, and someone will scratch mine," in which an individual decides to be a cooperator because of the person in need's reputation. He uses the example of Japanese macaques: low-ranking monkeys that groom high-ranking ones may improve their reputations (and receive more grooming) by being seen with the high-ranking monkeys Nowak calls "the top brass."

Nowak found that cooperation-defection works on several levels—an individual can simultaneously be a cooperator and a defector. The example Nowak uses is a group of employees at a company who compete ruthlessly against one another for promotions but also cooperate with one another to ensure that their company beats the performance of other companies. That insight about the complex nature of cooperation-defection is in alignment with the principles of systems biology—another field that has boomed in the last decade—which recognizes that biological insights emerge best from studying the dynamics of interacting systems rather than focusing on only one system. One case in point: medical science once attempted to understand heart disease by focusing on the function and structure of the heart. However, fundamental breakthroughs in cardiac disease were only recognized when the heart's function was studied in relation to the influence of other systems, such as the nervous, neuroendocrine, immune, and digestive systems.

Nowak's models also confirm what everyone who is agonizing over the current dismal state of our planet has noted—that cooperation is "intrinsically unstable": there are cycles when defection prevails. However, he also offers the good news that "the altruistic spirit always seems to rebuild itself." Nowak's sums up what he has discovered through his simulations, with the conclusion that "life is not just a struggle for survival but also a snuggle for survival."

Now more than ever, we need more research on the cooperative snuggle for survival lest we fall into a defection cycle during which we destroy ourselves and our planet. I believe we have been brought to the brink by our misunderstanding of evolution as simply a continuous struggle and quest for individual fitness (as measured by the number of one's "toys"). Human civilization has bought into the warning couched in the subtitle of Darwin's *Origin of Species* book: *The Preservation of Favoured Races in the Struggle for Life*—in other words, that life is an all-out struggle wherein the riches go to the fittest, regardless of the means by which they are attained.

According to this "scientific" principle, the less fit genetically deserve only what's left over . . . if anything. That mentality has brought us continuous wars over material possessions, overconsumption that has led to unsustainable resource exploitation, and increasingly unequal wealth distribution as well as an obviously ailing planet. The Darwinian focus on the fitness of the individual de-emphasizes the significance of communal cooperation in evolution.

One of the most striking areas where we have ignored the importance of cooperation among organisms is in our own bodies. In the decade since I decried our "war against microorganisms with everything from antibacterial soap to antibiotics," a wealth of damaging evidence has emerged about the toll this war is taking on our bodies.

The fact is that hundreds of trillions of microbial "invaders," mostly in our gut, are absolutely necessary for our survival, and there are ten times more of them than cells in the human body. Because the body cannot survive without its microbes (collectively called the "microbiome"), they are the functional equivalent of any of our other vital organ systems. In (belated) recognition of the importance of the microbiome, humans and most other organisms are now properly defined as superorganisms (complex organisms composed of many smaller organisms). (Saey 2013A) Again in belated recognition of the microbiome's importance, in 2007, the National Institutes of Health created the Human Microbiome Project to study it. Those scientists reported that humans and other animals form a life-sustaining bond with their gut microbes. Researchers have found that human genes influence the genetics of the microbiome, and the microbiome's genes (that make up 99 percent of the unique genes in our body!) regulate genes in our cells. (Saey 2013B)

In his alarming new book, *Missing Microbes: How the Overuse of Antibiotics Is Fueling Our Modern Plagues*, Dr. Martin J. Blaser, Director of the Human Microbiome Program at New York University, warns not only about antibiotic resistance but also about the declining diversity of the human microbiome that is increasing our susceptibility to chronic conditions from allergies and asthma to diabetes and obesity. For example, type 1 diabetes has been doubling in incidence about every twenty years in the industrialized world; in Finland, the incidence has risen 550 percent since 1950. Blaser writes that these modern epidemics are "not only diseases but also external signs of internal change." Recent studies have found that "otherwise normal individuals have lost 15 to 40 percent of their microbial diversity and the genes that accompany it" mostly due to the overprescription of broad-spectrum antibiotics that kill microbes indiscriminately. Yet Blaser, who has studied the microbes that populate our bodies for thirty years, calls them and their 20 million genes the "guerrilla warriors" that help us fight disease. (Blaser 2014)

While Blaser is warning about the declining diversity of our microbiome, other scientists are pointing with alarm to the declining diversity of our planet, where animal populations and species are decreasing at an alarming rate. Stanford scientists have tracked species abundance and population numbers over a period of time and found that extinction rates are up to a thousand times higher than they would be if people weren't in the environment generating pollution, deforesting, monocropping, and overharvesting. (Dirzo, et al, 2014) Many environmental scientists believe we have crossed the threshold for a major environmental collapse and are in the throes of the sixth mass extinction event to hit this planet.

Environmentalists have long known that the structure of localized ecological systems can shift abruptly and irreversibly from one state to another when stressed to critical thresholds. Evidence now indicates that the entire global ecosystem can react in the same abrupt way and is, in fact, currently in danger of doing so. Anthony Barnosky, a professor at the University of California, Berkeley's Department of Integrative Biology, and others argue that we are at a planetary "tipping point" because human activities are inducing Mother Earth to express a critical global transition. (Barnosky, et al, 2012) A recent study by NASA confirms that global industrial civilization is heading toward collapse in coming decades (i.e., soon!). (Ahmed 2014)

Civilization did not create global climate change (the planet has already been through five ice ages), but our behavior and technology are generating environmental stressors that exacerbate the impact of the climate change crisis. The process of societal rise-and-collapse has been a cyclical phenomenon throughout history, and in some cases, those collapse periods have lasted for centuries. While previous collapses primarily impacted localized human social systems, the coming collapse has already had a profound global impact on the health of the planet.

We now live in an era known as the Anthropocene, which emphasizes that human activities are causing massive changes to our natural world at an unprecedented rate. Not one location on our planet, from the southern tip of Antarctica to the heights of Mt. Everest, has remained untouched by human influence. For example, fossil fuel burning has left an imprint on our immediate environment while the thin veil of the Earth's atmosphere carries it to all portions of the globe. This reminds us of the following: (1) that we are all connected; (2) that we all leave an imprint; and (3) that the Earth that sustains us is finite. Today's global crises are warnings that we must stop exploiting the abundance and vitality of our living home and begin to reconnect and honor the planet as many traditional societies have done for eons.

Well, that's a cheery picture! However, as a flagrant optimist, I prefer to consider the positive side of Nature's resiliency. In 1883, a series of eruptions on Krakatoa in Indonesia led to new volcanic islands arising out of the sea. Lava flows on one of the islands in 1960 eliminated all life forms and left the island in a condition scientists actually refer to as a state of "sterilization." Surveys and studies monitoring the rise of flora and fauna on the islands for over five decades documented the abundance of an incredibly diverse ecology that has been thriving on these "sterile" islands since that time. In the aftermath of its catastrophic disturbance, the island's vital and thriving ecological paradise has since become more robust, expressing a diverse plasticity that enhances its ability to resist environmental stress. (Whittaker, et al, 1989) This lesson from Nature emphasizes the old adage, "What doesn't kill you will make you stronger."

I also take heart from the fact that organismal cooperation is not a nagging exception to the rule of evolution but instead one of its primary architects and that humans are (though it's hard to believe sometimes!), in Nowak's words, "supercooperators." Collectively, the cooperative accomplishments of human civilization have taken us to the Moon and beyond, and I hope our collective accomplishments will also take us to a restored planet, a restored microbiome, and beyond. After all, I have personally seen the dramatically positive changes that can occur when the cooperative behavior among my Caribbean medical students helped them evolve to become better humans, and more importantly, compassionate healers.