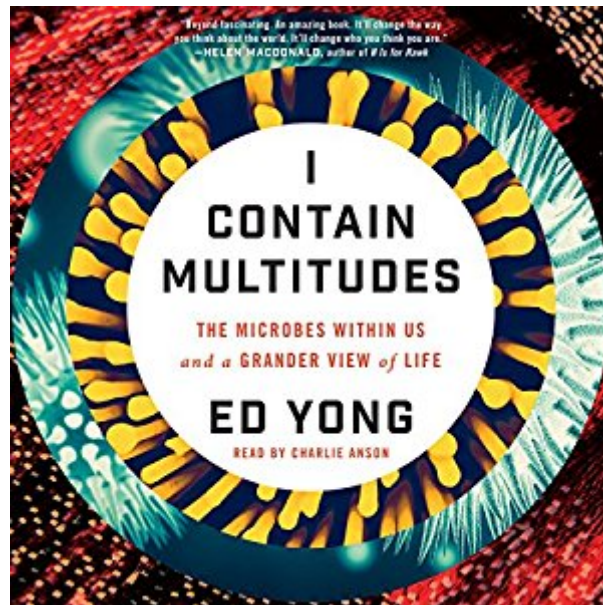


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# I Contain Multitudes: The Microbes Within Us And A Grand View Of Life



## Synopsis

Joining the ranks of popular science classics like *The Botany of Desire* and *The Selfish Gene*, a groundbreaking, wondrously informative, and vastly entertaining examination of the most significant revolution in biology since Darwin - a "microbe's-eye view" of the world that reveals a marvelous, radically reconceived picture of life on Earth. Every animal, whether human, squid, or wasp, is home to millions of bacteria and other microbes. Ed Yong, whose humor is as evident as his erudition, prompts us to look at ourselves and our animal companions in a new light - less as individuals and more as the interconnected, interdependent multitudes we assuredly are. The microbes in our bodies are part of our immune systems and protect us from disease. In the deep oceans, mysterious creatures without mouths or guts depend on microbes for all their energy. Bacteria provide squid with invisibility cloaks, help beetles to bring down forests, and allow worms to cause diseases that afflict millions of people. Many people think of microbes as germs to be eradicated, but those that live with us - the microbiome - build our bodies, protect our health, shape our identities, and grant us incredible abilities. In this astonishing book, Ed Yong takes us on a grand tour through our microbial partners and introduces us to the scientists on the front lines of discovery. It will change both our view of nature and our sense of where we belong in it.

## Book Information

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## Customer Reviews

With the growing Zika and Dengue threats, understanding how microbes and their hosts interact is vital. Not everyone can make it through this long and detailed account, but it is worth the effort. We

will all face questions that are addressed in this book - - from whether to pay extra for heavily advertised probiotics to whether or not to support the release of wolbachia-infected mosquitoes in our own backyards to stop the spread of deadly diseases. Without requiring specialist knowledge or vocabulary, the author introduces the complex concepts behind the recent revolution in understanding of microbes' role in health, evolution, ecology, and culture. A few years ago, before I retired from a medical practice in non-tropical Minneapolis, I had a patient whose unusual rash was probably caused by an African parasitic worm that hosts a bacterium which allows the worm to live inside its human host. By chance, I had just seen an article on treating his condition by giving antibiotics to eliminate the bacterium, thus allowing the patient's immune system to kill the worms. In an increasingly globalized world, the more people acquire the background to be able to absorb information like that and recall it when it becomes relevant, the better. Fortunately, the reader is rewarded with tidbits of levity along the way - - the name of a product aimed at restoring healthy digestive system microbes, for instance: "rePOOPulate." There's no cheerleading for every trendy "natural" "probiotic" cure under the sun. Nature is revealed as indifferent to our personal goals - - and capable of producing undesired results when we try to tamper with it. What we find here instead is a very balanced look at what has been learned and tried, what has worked and what has failed, and where we may be going.

It's time we became friends with microbes. And not just with them but with their very idea, because it's likely going to be crucial to our lives on this planet and beyond. For a long time most humans have regarded bacteria as a nuisance. This is because we become aware of them only when something goes wrong, only when they cause diseases like tuberculosis and diarrhea. But as Ed Yong reveals in this sweeping, exciting tour of biology, ecology and medicine which is pregnant with possibility, the vast majority of microbes help us in ways which we cannot possibly fathom, which permeate not just our existence but that of every single other life form on our planet. The knowledge that this microbial universe is uncovering holds tantalizing clues to treating diseases, changing how we eat and live and potentially effecting a philosophical upheaval in our view of our relationship with each other and with the rest of life. Yong's book shines in three ways. Firstly it's not just a book about the much heralded ^microbiome^ "the densely populated and ubiquitous universe of bacteria which lives on and within us and which rivals our cells in terms of numbers" but it's about the much larger universe of microbes in all its guises. Yong dispels many misconceptions, such as the blanket statements that bacteria are good or bad for us, or that antibiotics are always good or bad for us. His narrative

sweeps over vast landscape, from the role of bacteria in the origins of life to their key functions in helping animals bond on the savannah, to new therapies that could emerge from understanding their roles in diseases like allergies and IBD. One fascinating subject which I think Yong could have touched on is the potential role of microbes in seeding extraterrestrial life. The universal theme threading through the book is symbiosis: how bacteria and all other life forms function together, mostly peacefully but sometimes in a hostile manner. The first complex cell likely evolved when a primitive life form swallowed an ancient bacterium, and since this seminal event life on earth has never been the same. They are involved in literally every imaginable life process: gut bacteria break down food in mammals' stomachs, nitrogen fixing bacteria construct the basic building blocks of life, others play critical roles in the water, carbon and oxygen cycle. Some enable insects, aphids and a variety of other animals to wage chemical warfare, yet others keep coral reefs fresh and stable. There's even a species that can cause a sex change in wasps. Perhaps the most important ones are those which break down environmental chemicals as well as food into myriad interesting and far-ranging molecules affecting everything, from mate-finding to distinguishing friends from foes to nurturing babies' immune systems through their ability to break down sugars in mother's milk. This critical role that bacterial symbiosis plays in human disease, health and even behavior is probably the most fascinating aspect of human-bacteria co-existence, and one which is only now being gradually teased out.

Yong's central message is that the reason bacteria are so fully integrated into living beings is simple: we evolved in a sweltering, ubiquitous pool of them that was present and evolving billions of years before we arrived on the scene. Our relationship with them is thus complex and multifaceted, and as Yong demonstrates, has been forged through billions of years of messy and haphazard evolution. For one thing, this therefore makes any kind of simple generalization about them almost certainly false. And it makes us realize how humanity would rapidly become extinct in a world suddenly devoid of microbes. Secondly, Yong is adept at painting vivid portraits of the men and women who are unraveling the secrets of the microbial universe. Old pioneers like Pasteur, Leeuwenhoek and Koch come alive in crisp portraits (for longer ones, I would recommend Paul DeKruif's captivating classic, "Microbe Hunters"). At the same time, new pioneers herald new visions. Yong crisscrosses the globe, from the San Diego Zoo to the coral reefs of Australia to the savannah, talking to adventurous researchers about wasps, aphids, hyenas, squid, pangolins, spiders, human infants and all the microbes that are intimately sharing their genes with these life forms. He is also a sure guide to the latest technology including gene sequencing that has revolutionized our understanding of these fascinating creatures (although I would have appreciated

a longer discussion on the so-called CRISPR genetic technology that has recently taken the world by storm). Yong's narrative makes it clear that innovative ideas come from the best researchers combining their acumen with the best technology. At the same time his sometimes-wondrous narrative is tempered with caution, and he makes it clear that the true implications of the findings emerging from the microbiome will take years and perhaps decades to unravel. The good news is that we're just getting started. Thirdly, Yong delves deeply into the fascinating functions of bacteria in health and disease, and this involves diseases which go way beyond the familiar pandemics that have bedeviled humanity throughout its history. Antibiotics, antibiotic resistance and the marvelous process of horizontal gene transfer that allows bacteria to rapidly share genes and evolve all get a nod. Yong also leads us through the reasonable but still debated 'hygiene hypothesis' which lays blame for an increased prevalence of allergies and autoimmune disorders at the feet of overly and deliberately clean environments and suburban living. He discusses the novel practice of fecal transplants that promises to cure serious intestinal inflammation and ailments like IBD and Crohn's disease, but is also wary about its unpredictable and unknown consequences. He also talks about the fascinating role that bacteria in newborn infants' bodies play when they digest crucial sugars in mother's milk and affect multiple functions of the developing baby's body and brain. Unlike proteins and nucleic acids, sugars have been the poor cousins of biochemistry for a long time, and their key role in microbial symbiosis only highlights their importance for life. Finally and most tantalizingly, the book describes potential impacts that the body's microbiome and its outside guests might have on animal and human behavior itself, leading to potential breakthrough treatments in psychiatry. The real implications of these roles will have to be unraveled through the patient, thoroughgoing process that is the mainstay of science, but there is little doubt that the arrows seem to be pointing in very promising directions. There is grandeur in this view of life, Darwin said in his magnum opus The Origin of Species. And just how much grandeur there exactly is becomes apparent with the realization that Darwin was dimly aware at best of microbes and their seminal role in the origin and propagation of life. Darwin saw life as an 'entangled bank' full of wondrous species: I can only imagine that he would have been enthralled and stupefied by the vision of this entangled bank presented in Ed Yong's book.

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