



## March of the microbes. Sighting the unseen

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What do snowmaking machines, marine mudflats, limestone caverns, coral reefs, red tides, luminous fish, broad-bean plants, bright-colored hot Springs in Yellowstone Park, obesity, wood-eating termites, Château d'Yquem wine, the holes in Emmenthal cheese, and linen table cloths have in common? The answer is "microbes." John L. Ingraham, ASM former President and Professor Emeritus of Microbiology at the University of California, Davis, has devoted a whole life to the study of these tiny yet powerful organisms. A more than sixty year career has allowed him to do research in various fronts and to meet microbiologists that are currently myths of this science. He has also witnessed the development of technologies and new specialties that have helped microbiologists—and researchers in all fields of biology—to broaden the knowledge on the functioning of life, the links and relationships among living beings and between them and their environment, as well as the role of microorganisms in the biosphere.

Without the burden of academic duties, Ingraham can now handle microbiology as if it were only a hobby—which surely has been for him and for other microbiologists that have made of her career a hobby. One has the feeling that Ingraham has enjoyed himself very much writing *March of Microbes*. Since 1975, Ingraham has coauthored various editions of *The Microbial World* as well as other microbiology textbooks, one of them—*Introduction to Microbiology*—written with his daughter, Catherine Ingraham Vigran. Those that are acquainted with *Introduction to Microbiology* will surely remember how Ingraham used stories to introduce many topics and make them more comprehensible. He has used this tactics also in *March of Microbes*: by telling stories in which microorganisms are the main characters, he has brought microbiology closer to lay audiences. Even if one knows the book is about microbes, to learn what bizarre roles microbes can play either on their own or when humans tame them for their own behalf can be a surprise. And so can be to

know that microbes have been the only inhabitants in the Earth for almost 85 per cent of the history of life on the planet and that, as Ingraham himself states, they "did much more than arrive first." For microbes have shaped the planet and have made it as it is now, quite different from the Earth's nearest neighbours—Venus and Mars.

An introductory chapter ("The Microbial Landscape") provides the basis to become familiar with the various kinds of organisms that the word *microbe* comprises, to learn what kinds of living beings—or not alive, because many microbiologists do not consider viruses to be alive—make up the world of microbes, and how they grow and reproduce. From the very beginning we realize that microbes have been the most innovative and diverse living beings in their metabolisms although they do not look morphologically so diverse. Their wide range of nutrients and ways to obtain energy, as well as the range of growth temperature, pH, salinity, and hydrostatic pressure limits found in the microbial world account for their ubiquity. Many microbes can only be perceived through the changes they cause in the environment when they acquire energy. The book devotes a chapter ("Acquiring metabolic energy") to describe, with examples, various ways microbes have to obtain their energy.

The chapter "Food and drinks" goes far beyond describing the typical roles of microbes in the production of cheese, wine, etc. How do Swiss cheese get its holes? What makes a wine such as Portuguese *vinho verde* to be *pétillant*? What makes a Bordeaux wine—Château d'Yquem—acquire its unique flavor, taste, color and thickness? Why do raw eggs spoil more slowly than boiled eggs? What do microbes and thick salad dressings have in common? These are questions that find their answers in this chapter. Some kinds of symbiotic relationships including lichens, microbes in the guts of many animals, as well as light-emitting microbes that dwell in the light organ of various marine animals, are discussed in "Living together." Symbiosis between nitrogen-fixing bacteria and plants are included in the chapter "Cycling nitrogen", one of the three chapters that deal with the cycling of elements—the other two being "Cycling sulfur" and "Cycling carbon"—along with several environmental issues related to the cycling of those elements. The limits of microbial life, which are the limits of all kind of life, are discussed in "Hostile environments". The author, however, has kept for the last chapter ("Survivors") one kind of extremophiles: those like *Deinococcus radiodurans*, which endures intense radionuclide radiations.

Non-prokaryotic microorganisms have their own chapters: "Fungi, hostile and benign", "Viruses", and "Closer to us" (protists, "a sort of microbial leftover"), and so have pathogenic bacteria ("Felonious bacteria"). Probably because

much has already been written about the typical pathogenic bacteria, and concentrating in a 30-page chapter what takes hundreds of them in medical microbiology books would not have had sense, Ingraham focuses only on some aspects of these bacteria and their pathogenicity, and on the fight against infections. “Shapers of the planet” deals with global issues, and describes some roles microbes have played in the history of the Earth that have made our planet as we know it. Without mentioning Gaia, this chapter provides a Gaian vision of the Earth.

Most chapters of *March of Microbes* are easy reading, while others need some general microbiology knowledge that not all readers may have. To solve this problem, a glossary at the end includes definitions of many terms found throughout the text. In addition, the author uses metaphors to describe some molecules, processes and phenomena hard to understand by lay people. For example, ATP is described as “the indivisible unit currency of metabolic energy”; it is suggested that ATP synthase “could be viewed as a water wheel, generating mechanical energy from a flow of water”; and protons that accumulate outside the cell are shown “as a bank account in which metabolic energy is saved.”

In contrast with Ingraham’s—and other author’s—microbiology textbooks, which usually have plenty of full-color illustrations and pictures, *March of Microbes* includes only very simple black and white drawings and diagrams. In this book, it is the text—the stories told—that catches the reader’s attention and is worth thousand pictures.

Maintaining biodiversity has become a priority for many international institutions, and many projects are being carried out worldwide to study the diversity of life. The United Nations even declared 2010 to be the International Year of Biodiversity. Yet, in most programs to investigate and preserve biodiversity, the invisible biodiversity is ignored despite the fact that microorganisms have been the only inhabitants of the Earth for most of the history of life on the planet. As John Ingraham states at the beginning of the book, “[m]icroorganisms—microbes—are our progenitors, our inventors, and our keepers.”

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