A close-up photograph of a petri dish containing a microbial culture. The surface of the agar is covered with numerous small, dark, circular colonies of varying sizes, some appearing as distinct dots and others as small clusters. The lighting is soft, highlighting the texture of the agar and the distribution of the colonies. The background is a blurred, light-colored surface.

Microbes In The Service Of Mankind

Tiny Bugs with Huge Impact

DR. RAVINDER NAGPAL
DR. ASHWANI KUMAR
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MICROBES IN THE SERVICE OF MANKIND TINY BUGS WITH HUGE IMPACT

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PREFACE



Man has been exploiting microbes for centuries purposely or unintentionally for numerous benefit. Microorganisms are directly or indirectly involved in each and every activity of our everyday life. Be it healthcare, foods or ecosystem, they are imparting abundant benefits to the mankind, and making the planet livable for us. As the knowledge of microbiology grew, other biotechnological uses for the microbes were found. In more modern times, the use of microorganisms as biotechnological agents of profit has not only continued but has explosively increased. The modern tools of genetic engineering have fueled the use of microorganisms for economic gain and benefit. Other medical uses of microorganisms, particularly in the production of antibiotics, have been the greatest boon to humans and other animals. Microorganisms have also been harnessed as factories to produce various compounds, proteins, enzymes etc. that are used in different areas such as textile manufacture, agriculture, environment, health and nutrition etc. However, the literature associated with Microbiology, of necessity, tends to be specialized and focused. For that reason, it is difficult to find sources that provide a broad perspective on a wide range of topics related to beneficial microbes.

In this prolific context, the proposed book ***Microbes in the Service of Mankind: Tiny Bugs with Huge Impact*** is an innovative and conscientious compilation of wide arrays of potential benefits and possible applications of microorganisms in different areas viz. health and nutrition, disease prevention, agriculture, environment and industry etc. In a manner unique to this book, it meticulously recapitulates and reviews the personal research encounters and experiences of eminent researchers working in different specializations of microbiology and biotechnology; and hence, is certainly going to be exceptionally beneficial to diverse

juvenile researchers as well as eminent scientists by updating their knowledge and understanding of potential benefits and prospective applications of these wonderful microbes for the benefit of mankind as well as the planet. The concept behind this venture is to provide a single reference volume with appeal to microbiologists on all levels and fields, including those working in research, teaching, industry, and government. We believe that this book will be helpful, especially for accessing material in areas in which the reader is not a specialist. It is intended to facilitate preparing lectures and reports, and to satisfy curiosity regarding topics of beneficial microbes. Our intention is to provide affordable and ready-access to a large variety of topics of potential benefits of microbes within one set of covers. To this end, we have chosen subjects that, in our opinion, will be of greatest interest to the largest number of readers. Included are the general and potential chapters, brought up to date and augmented with current references. We have emphasized topics that are currently sizzling in the field of benefits of microbes, including additional chapters from other sources. The result is a volume where coverage is broad but not overly long in specific details. We believe this will be a most appropriate reference for anyone with an interest in the intriguing field of Microbiology.

This book addresses primarily students of microbiology and biotechnology. Beyond this scholastic use, its helpfulness extends to all professionals and most particularly to researchers and scientists working in the field of microbiology. This textbook has doubtless benefited from the extensive intellectual teaching and the insightful research experience of its authors, all of whom are renowned authorities in their fields. The authors would like to thank all colleagues whose contributions and opinion have been a great aid and who were so generous to share their research experience for better propagation of science.

The important thing, which is not generally comprehended, is that microbes have a massive influence on the economy and health of mankind. That, actually, is what this book is about. How these microbes could be valuable into our lives? What do they do for us? And why? And how we are able to or can further exploit their properties for the benefit of the mankind and the planet. We anticipate that the readers, be they an premature undergraduate entering the field or a professor who has been in the field for forty years, will be pleased about the elegant one-piece assemblage of wide array of benefits we get from microbes.

—*Authors*



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**MICROBES IN THE SERVICE OF MANKIND:
A BRIEF OVERVIEW**



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“Life would not long remain possible in the absence of microbes”- Louis Pasteur.

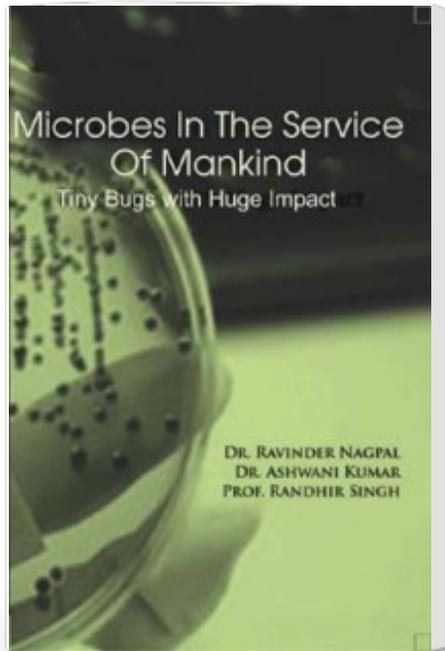
Ever since my college days, I was captivated with the field of microbiology. I always wondered how such tiny organisms are capable of affecting the lives of all the other living organisms in an enormous style. The theme always arrested my mind's eye. Today, microbiologists, in collaboration with cell biologists, molecular biologists, biochemists and immunologists employing many sophisticated molecular tools are rapidly trying to reveal that secret. Thus, it requires a great deal of efforts to assemble updated information in the form of a book and it was rather a monumental task. My goal with this book was to paint a bigger picture of how these microbes benefit us in different ways. When I was trying to be a microbiologist, I memorize there was scarcely any particular book that covered different beneficial microorganisms. And that fact literally provoked me for this collection and review of great deal of literature to provide updated materials to all my microbiology fellows.

This is a book about tiny bugs, known to scientists as microbes or microorganisms, the creatures which are largely too small to see, but populate every place on the globe where larger living creatures exist; they also inhabit many parts of the planet where no other kinds of organisms can survive. In fact, wherever the life exists, there will be microbes. As the scientist-writer Steven Jay Gould emphasized, we live in the Age of Bacteria. They were the first living organisms on our planet, live virtually everywhere life is possible, are more numerous than any other kind of

organism, and probably constitute the largest component of the earth's biomass. If truth be told, the most extreme environments that microbes can stand represent the limits within which life can subsist. And therefore, it would not be much erroneous if someone defines these microbes as God. I understand they are nowhere comparable to God, but, they are no less than God. For instance, God is someone who is everywhere. So are the microbes. They are present ubiquitously, on the earth, on the ground, in the air, in the water, in Antarctica, in deserts, in oceans, in the space, on our body, inside our body, in the agriculture; they are factually present everywhere (except for an operating autoclave or vacuum, on a funny note). Furthermore, God is someone who is unseen but we can feel his presence if we have faith in him. So is in the case of microbes. We cannot see them, but we can feel their existence in our life if we have faith in them. They are involved directly or indirectly in each and every activity of our daily life. And strangely but truly, without knowing, we have been getting their help from the historic days. The whole ecosystem depends on their activities, and they influence human society in countless ways.

The most important knowledge that should emerge from a microbiology book is the profound influence microorganisms have on earth and its residents. For billions of years, microbes have extensively shaped the development of the earth's habitats and the evolution of other life forms. It is understandable that scientists searching for life on other planets first look for signs of microorganisms. Being mostly invisible, the actions of microorganisms are usually not as obvious or familiar as those of larger plants and animals. They make up for their small size by occurring in large numbers and living in places that many other organisms cannot survive. Above all, they play central roles in the earth's landscape that are essential to life. They are deeply involved in the flow of energy and food through the earth's ecosystems. At the producer end of this range is photosynthesis, the formation of food using energy derived from the sun. Photosynthetic microorganisms, including algae and cyanobacteria, account for more than 50% of the earth's photosynthesis. In addition to serving as the basis for the food chains in the ocean and fresh water, these microorganisms also contribute the majority of oxygen to the atmosphere. Another process that helps keep the earth in balance is the process of biological decomposition and nutrient recycling. Decomposition involves the breakdown of dead matter and wastes into simple compounds that can be directed back into the natural cycles of living things. If it were not for multitudes of bacteria and fungi, many chemical elements would become locked up and unavailable to organisms. In the long-term scheme

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