Preface

Because microorganisms can adapt to virtually any physico-chemical environment and are efficient metabolizers, they are found everywhere. In fact, the true masters of life on Earth are not humans but microbes. They are essential for recycling biomass and for maintaining the biosphere. No discussion of infectious diseases can be completed without the description of human peaceful coexistence with a diverse microbial flora that inhabit our skin and guts. As they may well be the most brilliant and efficient chemists on Earth, microbes also attract interest as benefactors. They produce antibiotics, they genetically engineer disease-resistant plants, and they degrade pollutants.

Despite their huge importance, the fact is that much of what we know about microbes and microbial processes is based on the work done on only a handful of species–weed-like species which can be readily grown in laboratory culture. The vast majority of microorganisms found in nature (perhaps over 95 per cent) have not so far been cultured, but earnest attempts are underway to grow as many of them as possible in culture. An elegant diffusion chamber described recently allows growth of hitherto uncultured microbes in a simulated natural environment (see Chapter 5). It seems certain that their studies will pave the way to many novel processes and metabolic capabilities.

One most striking property of many microorganisms is their highly promiscuous mode of gene transfer among unrelated or remotely related taxa. Such horizontal (lateral) gene transfers have been the subject of intense research activity in the past few years in view of their strong bearing on the applicability of the biological species concept and the Linnaean system of bionomial nomenclature to prokaryotes.

The non-cellular viruses, lying at the borderline of the living and non-living, have traditionally, though uneasily, been described in textbooks of microbiology.

Viruses have erroneously been supposed to be simple creatures; in fact their enormous diversity and genetic promiscuity have made them a most creative force in evolution. It was only with the advent of nanoscience and nanotechnology that they started attracting interest as nano-organisms–most viruses have at least one dimension about or less than 100 nanometers (1 nm = 1 billionth of a meter). Importantly, the collective behaviour of matter can generate startling emergent properties between the micro- and nanometer scales–properties that clearly point to the nexus between biology and physics. Exceptionally, some giant viruses (*e.g.* mimivirus and phycodnaviruses) have all three dimensions greater than 100 nm, so are not strictly nano-organisms but in their structure and replication resemble other viruses. Viruses are therefore best treated under the new discipline of nanobiology. However, nanobiology is by no means confined to only viruses–all living cells contain a variety of subcellular organelles which behave as bionanomachines and so the processes and reactions involving the bionanomachines also come under the umbrella of nanobiology.

In the past two decades a silent revolution has transformed microbiology and created exciting opportunities for agriculture, medicine and industry. New technologies have enabled microbiologists to identify at least 20 previously unrecognized evolutionary groups of microbial life whose diversity dwarfs the better-known plant and animal kingdoms. Some new tools and techniques that have revealed the hidden microbial diversity include gene probing, genome sequencing, hybridization and DNA fingerprinting. For viruses, electron microscopy and atomic force microscopy have revealed spectacular hidden details.

Our agenda for the coming few years should be to identify the key organizational and generic principles underlying various morphogenetic processes in both prokaryotes and eukaryotes, while also pursuing the laborious elucidation of the molecular networks that control the organization of living matter. The extremely high complexity of living matter has compelled biologists to focus on a few 'model' organisms. This has no doubt been a productive approach but has led to a rather biased view–behind the apparent complexity, fundamental organizational principles based on physico-chemical laws are at work. The need of the hour is to critically examine these principles so as to understand how their ever-evolving combination leads to the dazzling diversity of patterns seen in the fascinating microbial world.

Besides the above, a few other currently active dimensions of microbiology and nanobiology that are briefly outlined in this monograph are cognition and natural genetic engineering, hyperthermophilic and other archaea, magnetosomes, metagenome libraries, microbial fuel cell, a bacterial time bomb, screening of microbes, microbial mats, medical biofilms, bilingual bacteria, and adaptive responses of microbes to toxic agents.

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