

## From Biosphere to Bioindustry

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Microbial community has played an important and decisive role in human life. Invasive pathogenic microbes have been a cause of human suffering throughout centuries; however, beneficial microorganisms have proved to be an essential part of our daily lives too. A prominent example is presence of microbial communities in our gut creating a delicate balance communicating with our internal cellular tissues effecting our health. From the early days, science and technology has exploited microbes for the benefit of mankind, beyond the natural interactions between microbes and man. It has been found that in ancient times, apart from exploiting yeast for beer and bread making, antibiotics were made as potions to mitigate/eradicate diseases. While primitive forms of fermentation have been known and practiced as an old technology, separation, and extraction of useful mixtures and much later on, purification of compounds have played significant part in welfare and well-being of human societies throughout centuries. The discovery of genes and the Central Dogma in molecular biology, and the application of this knowledge opened up an entirely new avenue leading to new products. This line of research is being continued with rigour witnessing new drugs, vaccines, vitamins, and basically many useful bioproducts at large scale. The role of enzymes of different classes participating in biosynthesis, transformation, and biodegradation of compounds has been recognised and developments in engineering design and construction of bioreactors, and advances in downstream processing have moved production scenery to another level. In addition, improved processing through intensification protocols, advanced control systems, nanotechnology and AI draw a new picture utilising technology with innovative ideas from mini-scale to large-scale for industrial-scale production. Furthermore, in recent decades the importance of microbial communication has been recognised and signalling processes between microbial units, when they get to a biomass threshold, have been acclaimed. This so-called quorum sensing process has multi-sector ramifications from pharmaceutical and food industry to agriculture, medical, biomedical, environment, and biotechnology. Advances in variety of multidisciplinary science and technology sectors including microbial genetics, molecular biology, microbial biochemistry, bioreactor design, downstream processing, control, and artificial intelligence have paved the way for a promising future for industrial biotechnology.