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Special Issue Article

The rising dominance of microbiology: what to expect in the next 15 years?.

Summary

What microbiology beholds after a decade and a half in the future requires a vision based on the facts and ongoing trends in research and technological advancements. While the latter, assisted by microbial dark matter, presents a greater potential of creating an upsurge in in-situ and ex-situ rapid microbial detection techniques, this anticipated change will also set forth a revolution in microbial cultivation and diversity analyses. The availability of a microbial genetic toolbox at the expanse will help complement the current understanding of the microbiome and assist in real-time monitoring of the dynamics for detecting the health status of the host with utmost precision. Alongside, in light of the emerging infectious diseases, antimicrobial resistance (AMR) and social demands for safer and better health care alternatives, microbiology laboratories are prospected to drift in terms of the volume and nature of research and outcomes. With today's microbiological lens, one can predict with certainty that in the years to come, microbes will play a significant role in therapeutic treatment and the designing of novel diagnostic techniques. Another area where the scope of microbial application seems to be promising is the use of novel probiotics as a method to offer health benefits whilst promoting metabolic outputs specific for microbiome replenishment. Nonetheless, the evolution of extraterrestrial microbes or the adaptation of earth microbes as extraterrestrial residents are also yet another prominent microbial event one may witness in the upcoming years. But like the two sides of the coin, there is also an urgent need to dampen the bloom of urbanization, overpopulation and global trade and adopting sustainable approaches to control the recurrence of epidemics and pandemics.

Introduction

In recent years, microbiome research has emerged as an integral component of all simple and complex ecosystems. The dynamism of microbial diversity has closely influenced the resilience of all life forms. Almost four centuries have been consumed to comprehend the remarkable influence of microorganisms on the host system after the first documentation of microbes by Antoine van Leeuwenhoek in the 17th century (Gest, 2004). Interestingly, in the last two decades, the insight into the microbial world has dramatically improved due to the recent advancements in science and technology. Over the years, microscopy and sequencing have emerged as two dominating technologies that have contributed to a farther expanse of microbiology as a discipline. These have enabled the human-kind to *see the unseen with profound depth*. Emphasizing more on sequencing, the cost of data generation and interpretation has dropped significantly leading to a massive amount of data in public repositories. For instance, it took almost 14 years (1990–2003) to completely sequence the first human genome, but a short span of slightly over a decade was sufficient to generate an integrated map of 2504 human genomes displaying structural differences (Sudmant *et al.*, 2015). The cost of sequencing the first human genome was $3 billion (Hood and Rowen, 2013), but we now hope to sequence human genome for less than $100 (Singh, 2018).

Given the vast new realm of microbiome research, we intend to emphasize prospective developments in microbiome research in the near future. To summarize the important advances in microbiome research and their future implications, this review tries to stitch in six key areas spanning: (i) The outreach of microbial dark matter in next decade; (ii) The future of drug resistance and its probable solution; (iii) Human microbiome: a promising solution in the coming decade; (iv) The future prospects of probiotics and (v) Frontiers of space microbiome in the next decade and (vi) The next pandemic we may expect.

The outreach of microbial dark matter in the next decade

The inception of the word dark matter in microbial context was proposed to infer the existence of the vast majority of microbes which has not been axenically cultured and at the same time, their existence is supported by metagenomic gene inventories (Marcy *et al.*, 2007). Prof. Julian Davis, University of British Columbia quoted that 'Once the diversity of the microbial world is