Nanobiotechnology: A Novel Tool in Microbiology

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New technologies bring new capabilities to many fields of research. Molecular biology revolutionized our understanding of microorganisms by empowering our ability to investigate and manipulate their genomes in molecular level. The field of micro/nanotechnology is beginning to impact on microbiology. The development of physical techniques allowed us to produce well defined structures at micron or submicron scales that have wide applications in microbiology. The scale of microstructure is compatible to the physical dimension of most microorganisms, and these tools are useful to manipulate individual cells and their extracellular microenvironment. A number of problems associated with microbiology will benefit from the development of these tools. It will include the biology of single cells. The measurements based on ensemble averaging are not suitable to characterize the differences between individual cells. We now know that individual cells can differ from each other biochemically and behaviorally even though they are originated from single colony. But we have little knowledge on the significance of the differences yet [1]. The development of microstructure for isolating and characterizing single cell will improve our understanding of the variations between cells. Another area that can benefit from the new technologies is isolation of unculturable microorganisms. We can isolate and culture only tiny fraction of microorganisms from total species in nature using conventional culture methods [2]. There have been just little changes in the microbial culture techniques since the beginning of microbiology in nineteenth century. The physical and chemical microenvironment surrounding cells are important to the homeostasis and growth of microorganisms. Understanding the role of microenvironments such as temperature, surface properties, physical spacing, stress, diffusion of molecules related with metabolisms and communications will improve culture techniques for diverse microorganisms. Other areas will include cellular communications, intracellular organization, characteristics of multicellular structures, and mechanisms of differentiation and behavior [3].

Microfabrication is a key component in this imminent revolution. Microfabrication is a set of techniques for crating microstructures and nanostructures based on photolithography and electron beam lithography. Soft-lithography is in particular useful in biological applications due to the simplicity, low cost and compatibility with cells [4, 5]. Microfabricated tools will bring new capability to the growing field of quantitative microbiology. Thousand of parallel experiments with single cell can be carried out under identical condition. It will transform microbiology from qualitative field into more quantitative one with statistically more solid data. Moreover, micro/nanotechnology can bridge physical scientists with microbiologists, and close

collaboration between these groups will lead to the development of powerful tools for microbiology or even possibly open new scientific field.

References

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