# 凝聚态物理-北京大学论坛

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# Disorder develops into order, and order impacts bacterial biology

## Prof.Vernita Gordon

**Abstract** Bacteria are typically thought of as single-celled organisms. Yet, bacteria often form biofilms, which are multicellular communities of interacting bacteria. These biofilms show emergent properties of types normally associated with more-traditional multicellular systems, higher eukaryotes (like humans!). For example, cells in biofilms signal each other and have differentiated gene expressions. Biological tools give us good control over, and readouts for, bacterial gene expression, which makes bacterial biofilms excellent model systems to study for understanding how multicellularity works. Most chronic bacterial infections, and most hospital-acquired infections, are in biofilm form. Among the emergent properties of biofilms are greater resistance to antibiotics and greater damage to host tissue. Understanding how this happens would allow the development of targeted strategies for preventing, disrupting, or ameliorating biofilm infections. Thus, understanding the development of biofilms is important both from a basic-science and an applied-science perspective. When bacterial systemolop from individual bacteria into biofilmo, several typeof order develop in the system. Bacteria attach to a 2-D surface, rather than being freely suspended in a 3-D medium. Bacteria cluster together in dense groups called microcolonies, rather than being isotropically distributed on the surface. The maturing biofilm has specific arrangements of cells and extracellular material that provide an anisotropic environment with physical and chemical characteristics very different from those of an isotropic aqueous growth medium. We examine these cases to understand both how bacterial biology results in the development of order to take the system into a biofilm state, and also how the different types of order, or structure, present in the system impact bacterial biology. We find that adhesion to a surface increases the rate of bacterial growth over that in a liquid medium, and that intermediate (weaker) adhesion results in an intermediate growth rate. We find that bacterial signals respond differently in an amphiphilic environment modeling that found in a biofilm. Finally, we present preliminary results on the effect of spatial structure on the evolution of antibiotic resistance.

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*Photograph by Xiaodong Hu*