Mathematics and Molecular Biology

Life is different because it is inherited. All life comes from a blueprint (genes) that can only make proteins. Proteins are studied by more than one hundred thousand scientists and physicians every day because they are so important in health and disease. The function of proteins is on the macroscopic scale, but atomic details control that function, as is shown in a multitude of experiments. The structure of proteins is so important that governments have spent billions of dollars studying them. Structures are known in exquisite detail determined by crystallographic measurement in some 10^5 cases. But the forces that govern the movement and function of proteins are not visible in the structure. Mathematics is needed to compute both function and forces so comparison with experiment can be made. The mathematics must be multiscale because atomic details control macroscopic function. The device approach of engineering and physiology provides the dimensional reduction needed to solve the multiscale problem. Mathematical analysis of hundreds of experiments has been successful in showing how some properties of an important class of proteins—ion channels— work. I will present the Fermi Poisson approach started by Jinn Liang Liu and being developed much further by Dexuan Xie. The Fermi distribution is used to describe the saturation of space produced by crowded spherical ions. A fully consistent mathematical description produces macroscopic features of the atomic detailed structures that fit data in a wide range of conditions surprisingly well with a handful of parameters never changed.