Some aspects of statistical mechanics in complex biology: selective transports and like-charge attractions

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Nuclear pore complexes (NPCs) mediate the bidirectional traffic of macromolecules between the cytoplasm and nucleus in all eukaryotic cells. Despite its vital importance, there is still debate on the underlying mechanism by which the NPCs perform the selective gating. Here, we will introduce a self-contained theory that predicts fluctuating conformations of FG nups, in accord with recent observation, and quantitatively describes the macroscopic transport. It is found that the translocation barrier of fluctuating FG nups varies according to molecule size and transport factor (TF). Calculating current and transit time, different transport regimes are identified, which explains the size-selective permeability by TF and also reveals cooperative role of RanGTP for efficient transport across NPC. In the latter half of this talk, we will discuss the charged polymer condensation induced by polyamine ions. A computer simulation study shows that the point particle assumption of ions usually adopted in theoretical studies can be oversimplification for polyamines and the sign of interaction between charged objects can change as taking into account the extended rodlike structure of ions.