Artificial nanopores that mimic the transport selectivity of the nuclear pore complex

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***Short Abstract* — Passage of materials across the nuclear envelope is governed by an effective and robust gate, the nuclear pore complex (NPC). Natively disordered proteins, termed FG nups, line and partially fill the ~30nm wide central conduit and present a selective barrier for transport. This barrier can be overcome by the specific binding of transport molecules to the FG nups. To test whether no more than a passageway and a lining of FG nups are sufficient for selective transport, we designed an artificial nano-device that incorporates just these two elements. We demonstrate that this simple nano-device exhibits key properties of the NPC.**

***Keywords* — Nuclear pore complex, FG nups**

NPCs are large protein assemblies that span the nuclear envelope and allow selected proteins and macromolecular complexes rapid entry and exit to and from the nucleus, whilst limiting the passage of others of similar size and charge. NPCs are comprised of an elegantly simple core scaffold that defines a ~30 nm diameter passageway between the nucleus and cytoplasm and anchors natively disordered FG (phenylalanine-glycine) repeat rich proteins, termed FG nups [1, 2]. The FG nups are packed densely enough to form an effective barrier to the diffusion of most macromolecules. However, cargo-carrying transport factors overcome this barrier by transient binding to the FG nups [3]. Although the detailed translocation mechanism remains to be fully elucidated [4-6], key components of the gate are small diameter channels that are occluded by the FG nups and binding of transport molecules to these FG nups. To test whether these two features are sufficient for selective transport, we assembled an artificial nano-device incorporating just these elements.

Our device consists of a polycarbonate membrane perforated with ~30 nm diameter holes and coated on one side with an FG nup layer. The device efficiently passes proteins that specifically bind this FG nup whilst significantly inhibiting the passage of proteins that do not, recapitulating a key feature of NPC-mediated trafficking. We show that passageway diameter, binding strength to the FG nup, and competition for binding sites and space inside the pore are important determinants of efficient selectivity. Nano-devices of this kind are useful for assessing the significance of parameters that govern NPC gating, and provide an initial blueprint for the construction of other efficient nano-selective filters. Such devices have many potential applications including the purification of macromolecules and pharmaceuticals.

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