Living systems use selective filtering to direct molecular traffic, balancing specificity with speed of transport. One example of an unusual biofilter is the nuclear pore complex (NPC), which controls transport of macromolecules between a cell’s nucleus and cytoplasm. The NPC is a channel lined with disordered FG nucleoporin proteins, which block the passage of most macromolecules but allow a high flux of transport factor proteins and their cargo. We sought to determine minimal features from the NPC which were sufficient for selective transport and could be generalized to other biofilters. Combining modeling and experiment, we determined that selectivity can arise from bound-state diffusion resulting from transient, multivalent binding interactions to flexible molecular tethers.