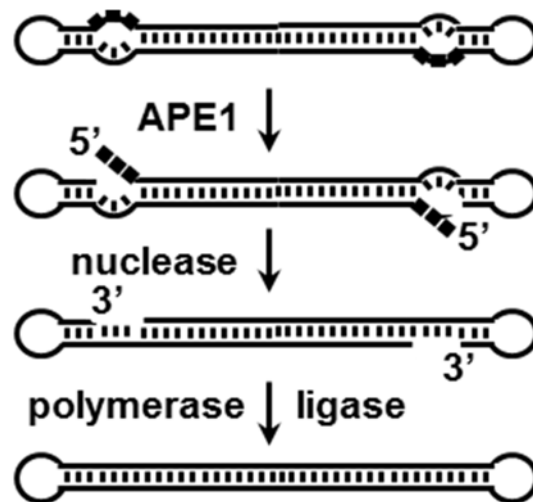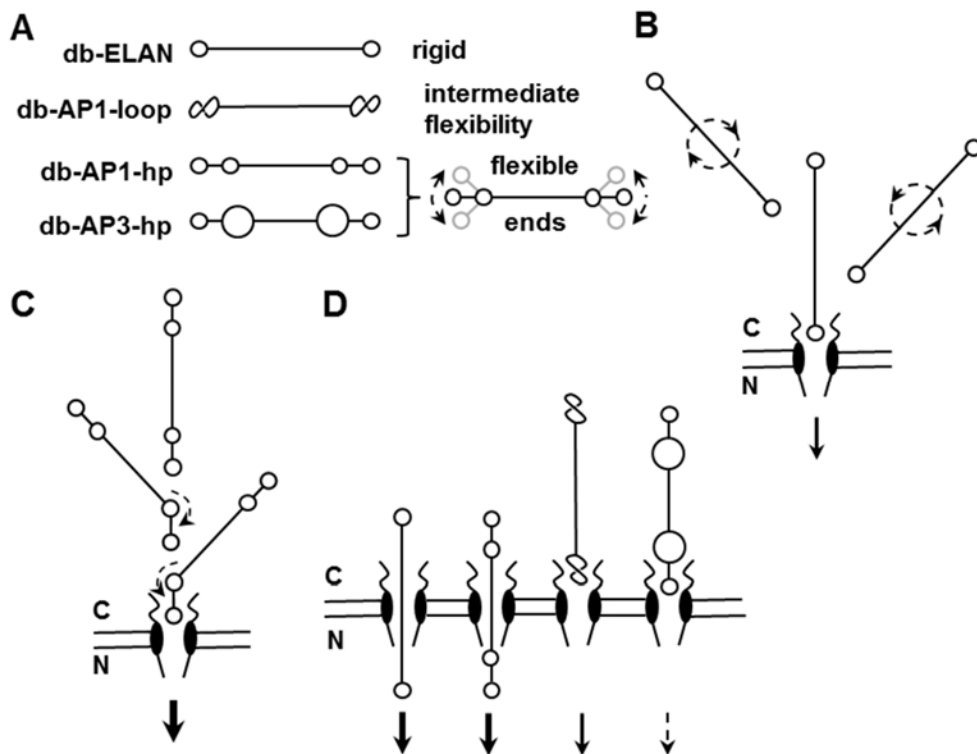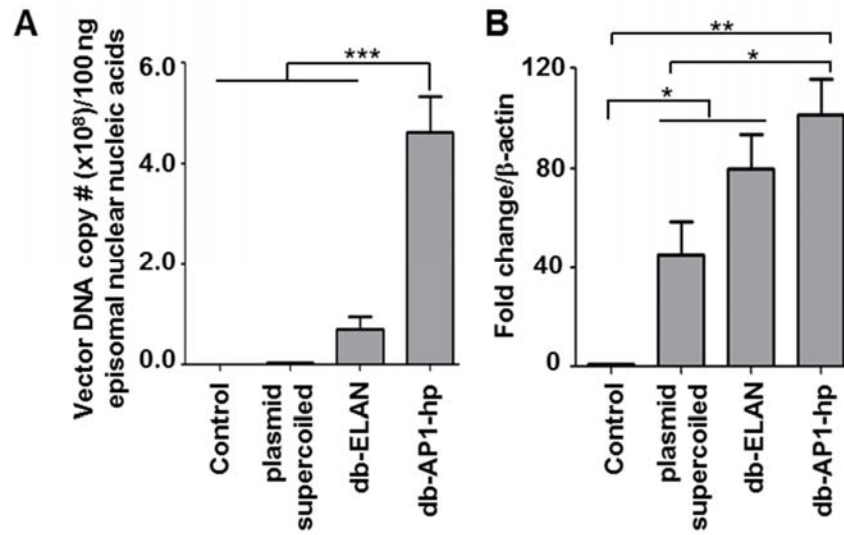**Supplementary Data**

Supplementary Figure 1

Supplementary Figure 1. gpPCR-generated dumbbells harbour abasic sites that trigger the formation of internal loops close to the ends of the dumbbells. Abasic sites can be cleaved by the apurinic/apyrimidinic enzyme 1 (APE1) in human cells prior to base excision and/or nucleotide incision repair.

Supplementary Figure 2

Supplementary Figure 2. Model describing facilitated NPC entry by dumbbell vectors with flexible ends. A, Internal loops generated by hairpin-gap-primer PCR trigger increased flexibility of dumbbell ends. B, Rigid dumbbells might enter the NPCs only when approaching them in nearly perpendicular orientation to the nuclear membrane. C, The more flexible ends of the gpPCR-dumbbells could facilitate dumbbell entry into the NPCs even from more oblique angles. D, Dumbbells harbouring small loops might freely pass through the medium-sized NPC channels; however, larger loops may enlarge the DNA effective diameter beyond the cut-off value for passage through midsize NPC meshes, forcing them to enter the nucleus via the much less abundant larger channels.

Supplementary Figure 3

Supplementary Figure 3. Nuclear vector delivery (A) and transcriptional vector activity (B) measured by qPCR or qRT-PCR respectively. Values in B refer to the control value 1. Values are mean values ± SEM of three independent experiments. The statistical analysis was performed using repeated one-way ANOVA plus a post-hoc Newman-Keuls test. The significance was denoted as *** $p < 0.001$; ** $p < 0.01$; * $p < 0.05$.