Supporting Information

Transition of cationic dipeptide nanotubes into vesicles and oligonucleotide delivery

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**Experimental section**

**Complexes of CDPNTs/ss-DNA:** CDPNTs were self-assembled by dissolving 5 mg cationic dipeptide (Bachem, Switzerland) in 40 μl 1,1,1,3,3,3-hexafluoro-2-propanol (HFP, Sigma-Aldrich) followed by a dilution into a pH 7.2 aqueous solution with a 10mg/ml concentration by 460 μl aqueous solution of either pH 7.8 NH$_3$·H$_2$O or pH 7.2 phosphate buffer saline (PBS). Afterwards, a 30 μl (2 OD/ml) solution of ss-DNA labeled with 5-(5-aminopentyl) thioureidyl fluorescein (5′-TCC TGT GTG AAA TTG TTA-3′-fluorescein, synthesized by SBSbio in China) was added. To eliminate the cytotoxic HFP, the complexes of CDPNTs/ss-DNA were dialyzed for 2 hours with constant magnetic stirring against a PBS solution. The resulting complexes were kept overnight prior to use.

**Microscopy:** The SEM images were acquired by an S-4300 (HITACHI, Japan). TEM was carried out by a Philips CM200-FEG. The AFM images were recorded with a Nanoscope IIIa (Digital Instruments, Veeco Metrology Group) in tapping mode in air. Confocal microscopy images were obtained by using a CLSM, Olympus FV500.

**CD spectra:** The CDPNTs and the vesicles were monitored with a JASCO J-810 spectropolarimeter at room temperature between 190 nm and 300 nm. Samples of the different concentration of CDPNTs or the zwitterionic DPNTs on a quartz chip were measured at 50 nm min$^{-1}$ with 0.5 nm step size. Each spectrum was the average of four measurements.

**Gel retardation studies:** ss-DNA was diluted to a chosen concentration (~ 0.05μg/μL) using pH7.2 PBS solution. Then an appropriate amount of solution of CDPNTs, or zwitterionic PNTs, or cationic dipeptide (~ 10μg/μl) in pH7.2 PBS solution was added into ss-DNA solutions. The amount of materials added was calculated based on a designed
volume ratio of material/ss-DNA. After the solution was incubated at ambient temperature for 1 h, the formed material/ss-DNA complexes were mixed with a loading buffer and loaded onto 1.2% agarose gel containing gold view (a nucleic acid dye, SBSbio in China). Gel electrophoresis was run at room temperature in TBE buffer (45 mM, pH=7.4) at 100 V for 30 min. The ss-DNA bands were visualized by a UV illuminator (transmission light) and photoed by a digital camera.

**Incubation of HeLa cells with the CR-CDPNTs or the complexes of CDPNTs/ss-DNA:** HeLa cells were seeded in a 35 mm glass-bottom Petri dish at 37 °C and 5% CO₂ atmosphere for 2 h in DMEM cell culture medium (Invitrogen) supplemented with 10% fetal bovine serum (FBS) prior to incubation with the CR-CDPNTs or the complexes, respectively. Then, 50 μl of the CR-CDPNTs or the complexes were added to the HeLa cells with 1 ml growth medium. The cells were continuously incubated for 24 h at the conditions mentioned above in an incubator. The cells were rinsed twice by changing the culture medium and then characterized by CLSM.
Figure S1 (a) TEM image of the vesicles with negative staining by uranyl acetate. (b) Cross-sectional AFM scan (area: 12.5 $\mu$m $\times$ 12.5 $\mu$m) of the vesicles revealing the height of the vesicles.
Figure S2. TEM images of the different concentration of CDPNTs with negative staining: 8 mg/ml (a) and 1 mg/ml (b).
Figure S3. SEM images of the zwitterionic DPNTs (a) at the concentration of $C = 10 \text{ mg/ml}$; (b) with a high magnification at the concentration of $C = 10 \text{ mg/ml}$; (c) at the concentration of $C = 2 \text{ mg/ml}$; (d) with a high magnification at the concentration of $C = 2 \text{ mg/ml}$. 
TEM and SEM images of CDPNTs attached with ss-DNA

Figure S4 (a) TEM and (b) SEM images of the CDPNTs attached with ss-DNA measured after four weeks.
Gel retardation analysis

Figure S5. Agarose gel electrophoresis retardation of ss-DNA by (a) CDPNTs, (b) zwitterionic DPNTs, (c) cationic dipeptide. The respective materials to ss-DNA volume ratio used to form each complex were given above the corresponding lane. It is noted that the cationic dipeptide solution was prepared by dissolving 5 mg cationic dipeptide in 40 μl N,N-dimethylformamide (DMF) followed by a dilution into a 10 mg/ml aqueous solution with a pH 7.2 PBS.
TEM and CLSM images of CR-CDPNTs

Figure S6. (a) TEM image of a CR-CDPNT; (b) CLSM image of the CDPNTs labeled by Congo red.
Figure S7. CLSM images of (a) HeLa cells (Right, bright field image) after 24 h incubation with the complexes of CDPNTs and fluorescently labeled ss-DNA (green), (b) positive control cells (Right, bright field image) after 24 h incubation with the CDPNTs labeled by Congo red, (c) cells after 24 h incubation with ss-DNA alone and (d) cells after 24 h incubation with zwitterionic dipeptide. It is noted that the zwitterionic dipeptide solution was prepared via dissolving diphenylalanine in pH 4 ~ 5 HCl solution.