Supporting Information

Transformable Protein-Gold Hybrid Materials Serve as Supramolecular Vehicles for Gene Delivery

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Experimental Section

Chemicals. Chemicals such as bovine serum albumin (BSA), tryptophan, agarose, DTT, D-Sorbitol were purchased from BejingDingguoChansheng biotechnology (Beijing, China). Chloroauric acid ($HAuCl_4$) was purchased from Sinopharm Chemical Reagent (Shanghai, China).Other reagents such as PEG3350, yeast extract, tryptone, phosphate buffer, glucose, sodium hydroxide (NaOH), hydrochloric acid (HCl), sodium chloride (NaCl), Tris, HEPES were obtained from Tianjin Guangfu technology (Tianjin, China). Milli-Q system has been supplied double-distilled water (dH_2O) for all experiments.

Instruments and Characterization. Fluorescent spectrometer (5301PC) was from Shimadzu (Tokyo, Japan). Sample incubation and cell culture work was carried out by using Isothermal Incubator (ISRDS3, Crystal, Suzhou, China). High-speed refrigerated centrifuge (Zhongkezhongjia Scientific instruments, Hefei, China) was used for centrifugation experiments. For bioimaging studies, confocal fluorescent microscopy (CFM) was used (Carl Zeiss Jena, Germany). Sample morphological analysis in nano-scale was carried out by suing scan electron miscroscopy (SEM) (SU8020，HITACHI，Tokyo，Japan). The size and ζ potential of the synthesized particles were investigated by using the Malvern ZEN 3600 Zetasizer (Malvern Instruments, UK).

DNA Purification. Plasmid DNA isolation and purification from *Escherichia coli* were performed by using DNA isolation kit (Beijing Solarbio Science & Technology, Beijing, China).The concentration of plasmid DNA was determined by using Eppendorf Biophotometer Plus **(**Eppendorf China Ltd, Shanghai, China**)**.

Synthesis of BSA-AuNCs.

The synthesis of BSA-AuNCs was according to **ref**. Briefly, $HAuCl_4$ solution (5 mL,10 mM) was mixed with BSA solution (5 mL, 50 mg/mL) and mixed at 37℃ for

2 minutes. NaOH solution (0.5 mL, 1M) was then added into the solution. The mixture was further incubated at 37℃ for 12 h.

Buffers. The PBS buffer (1x, pH 7.4) was used for all the relevant experiments if otherwise not stated.

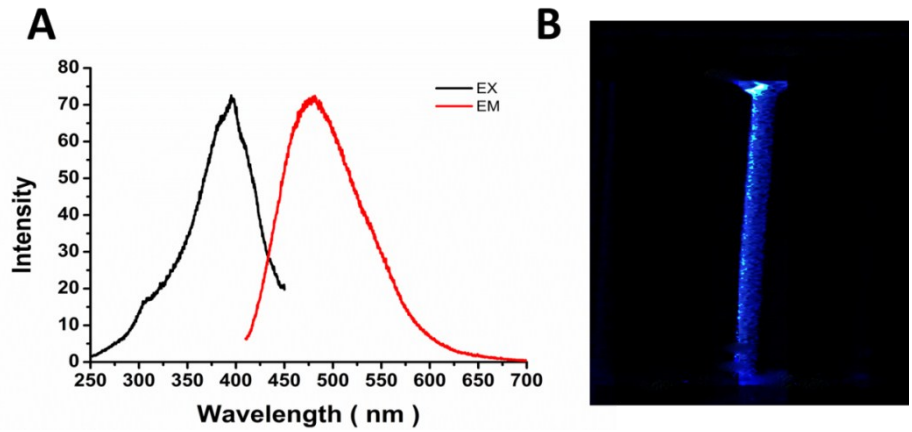

Fig. S1 Fluorescence characterization of PGHNs. (A) The excitation and emission peaks of PGHNs were localized at 395 and 480 nm, respectively. (B) The blue emission of PGHNs under UV irradiation at 365 nm.

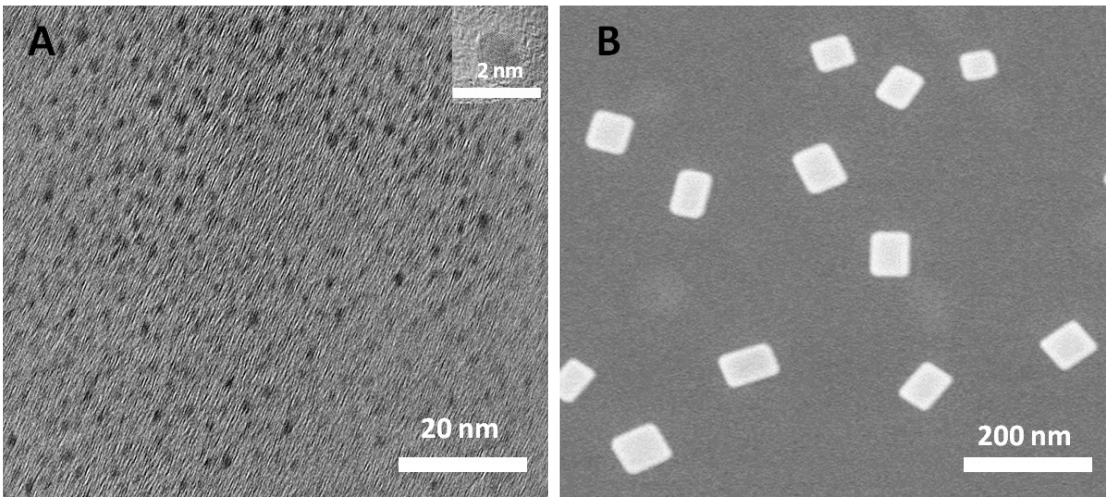

Fig. S2 The conjugated Au NCs within PGHNs (A) and enlarged SEM images of PGHNs (B).

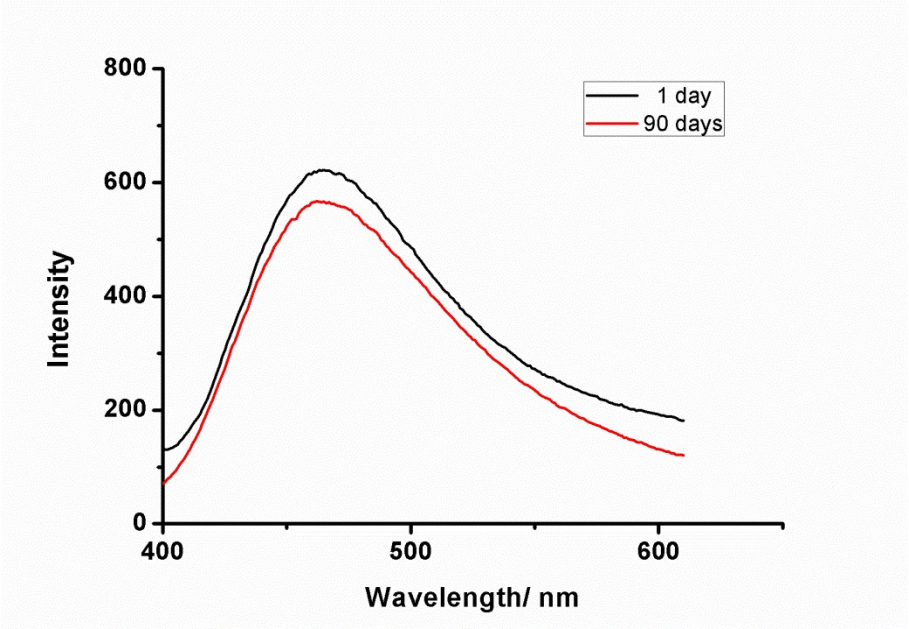

Fig. S3 The photostability of PGHNs was measured using fluorescence spectra. No big difference can be observed between the freshly prepared PGHNs and stored PGHNs (in fridge for 3 months).

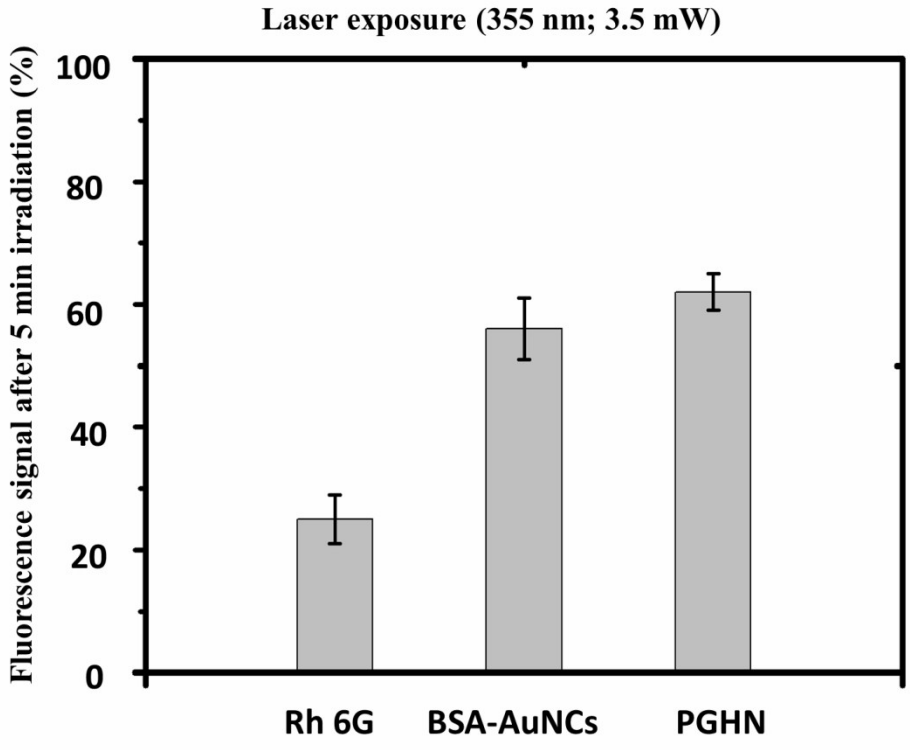

Fig. S4 The photo breaching of PGHNs was measured Rh 6G and BSA-AuNCs (ref 27). The excitation was 355 nm with strength of 3.5 mW for 5 minutes.

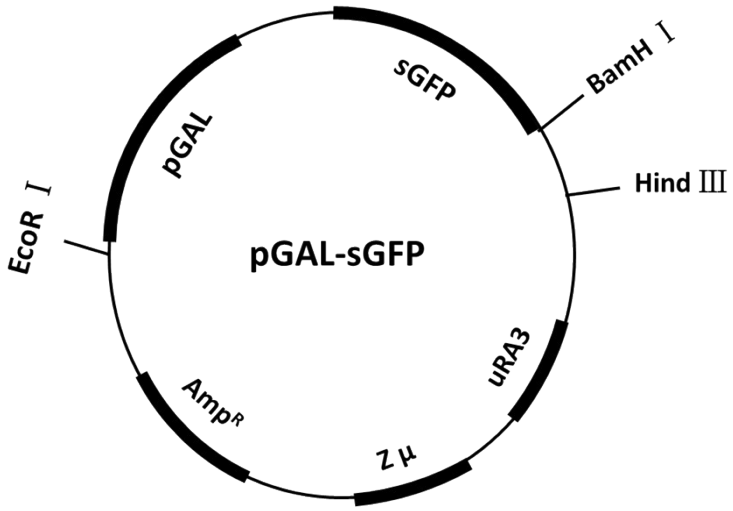

Fig. S5 Plasmid map of pGAL-sGFP.

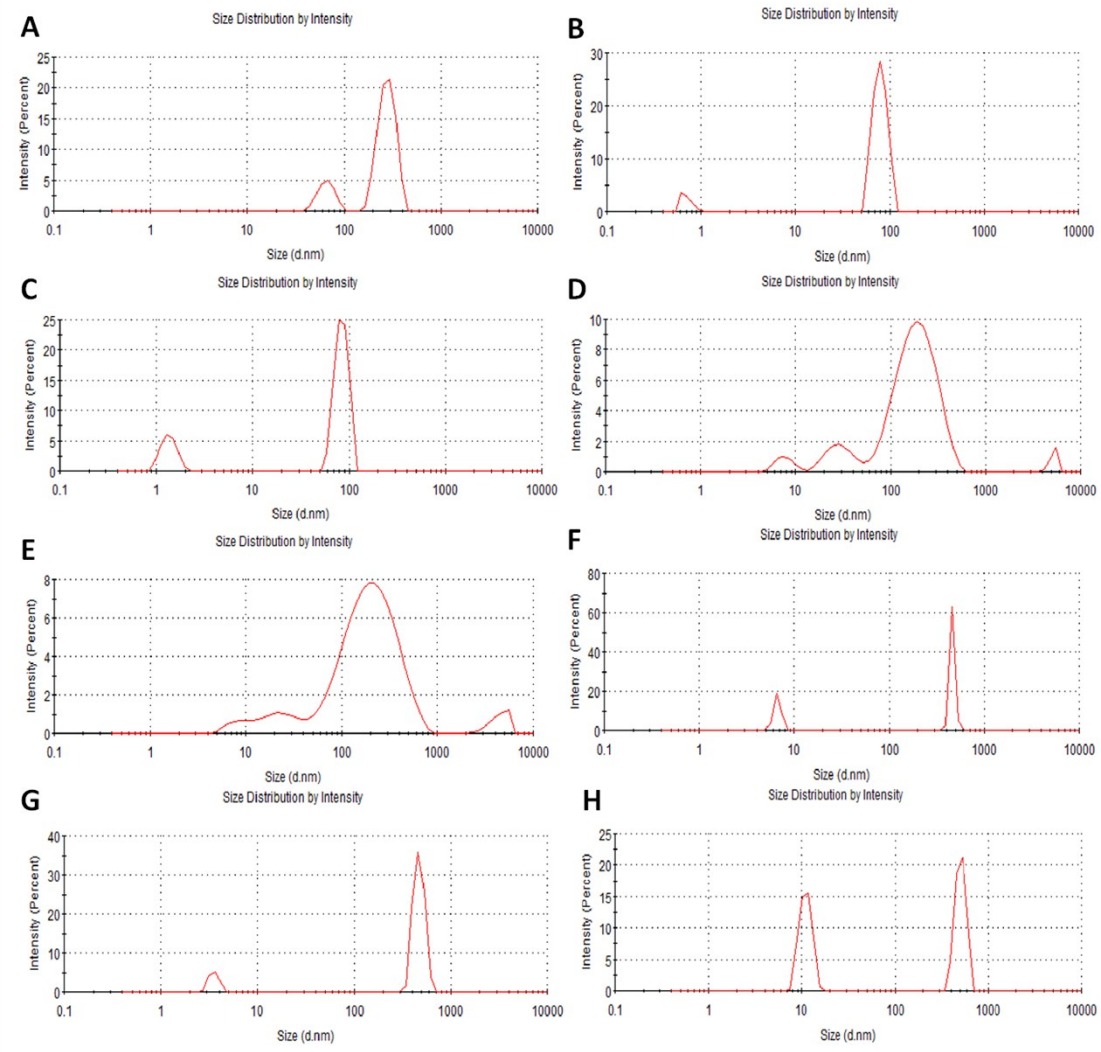

Fig. S6 DLS analysis of DNA (A), PGHN (B) and assembly samples of PGHN-DNAs during the assembly process (2- 12h). The statistical values of main peaks of C-H were summarized in Fig. S5.

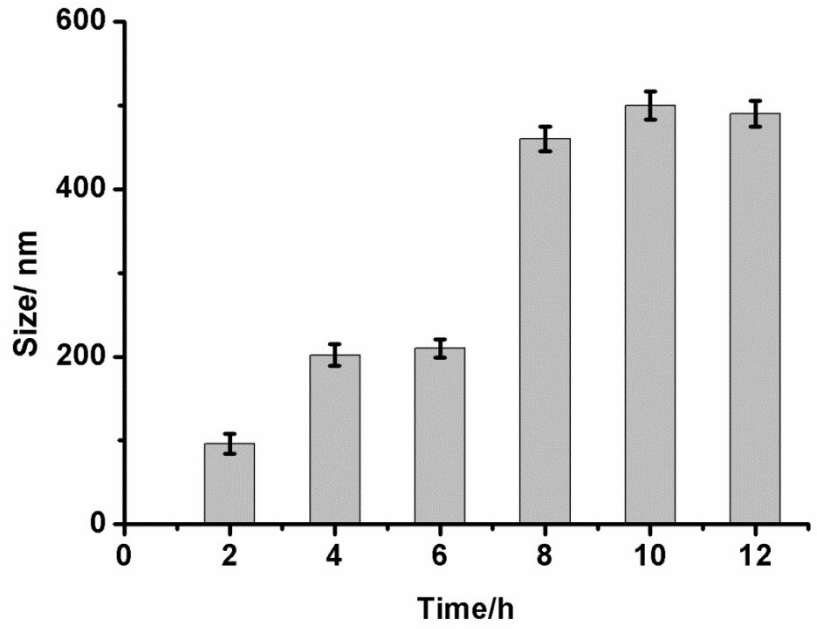

Fig. S7 DLS showed the size change of PGHN-DNAs during the assembly process, shifting from 90 to 500 nm. The value are plotted as mean ± SD (n = 3).

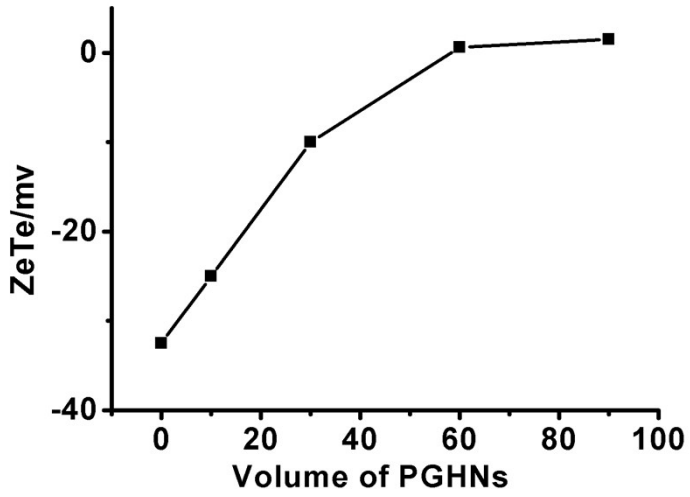

Fig. S8 The zeta potential of PGHN-DNAs was gradually increased and approached zero following adding with increased content of PGHNs.

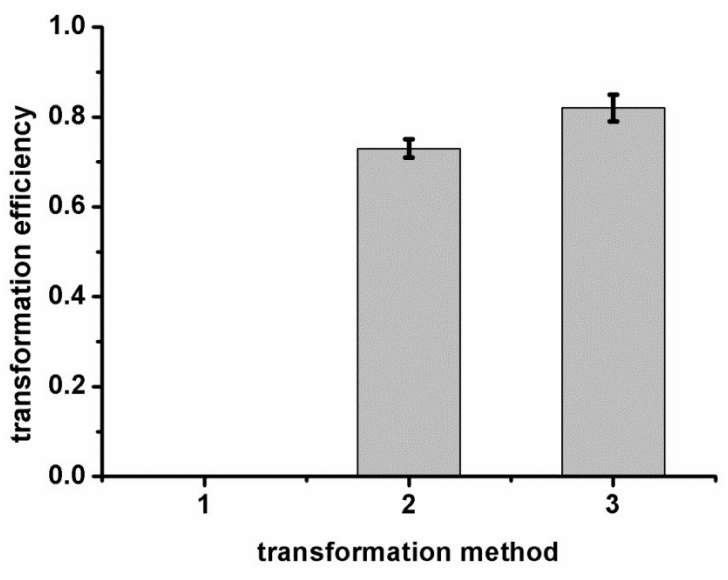

Fig. S9 The transformation efficiency using different methods, suggesting that the proposed new method was slightly more efficient. 1, 2, and 3 referred to cells transformed by using naked DNAs, traditional trimix-heat-shock approach, and the present method. The value are plotted as mean ± SD (n = 3).