Supplementary information

Main chain poly(bile acid)s directed plasmonic nanospheres with amphiphilic binding pockets and photo-triggered destruction

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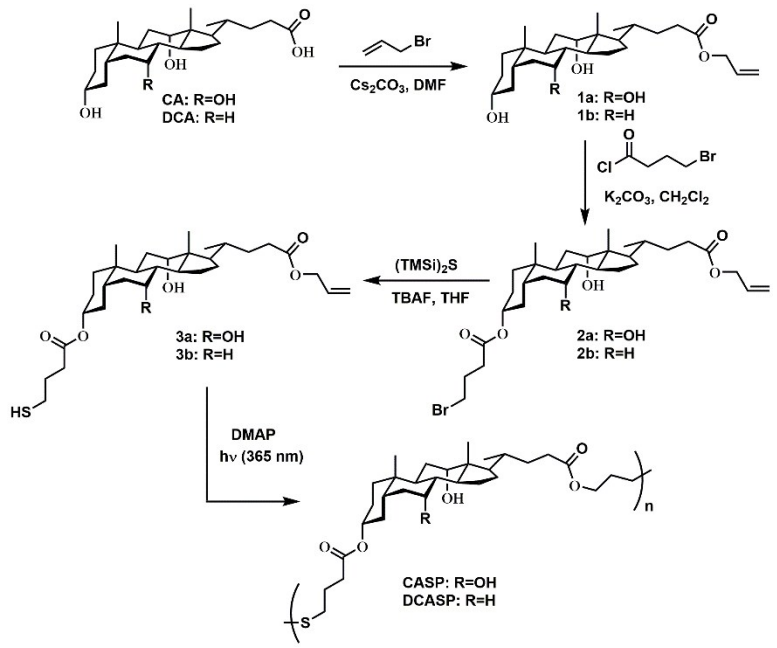

Scheme S1 Synthetic procedure for sulfide-bridged main chain poly(bile acid)s.

Monomer preparation

Terminal ethylenes 1a and 1b: To a solution of bile acid (25 mmol) in anhydrous Dimethyl Formamide (DMF) (60 mL), caesium carbonate (8.15 g, 25 mmol) was added and the mixture was stirred under an inert atmosphere at room temperature. After stirring for 1 h, allyl bromide (2.62 mL, 31.25 mmol) was added. The reaction was monitored by TLC. When the raw materials disappeared, cold water (400 mL) was added and the solution was acidified with 2 M $KHSO_4$. The precipitate was filtered and then dissolved in CH_2Cl_2. The crude product was extracted with H_2O and brine respectively. Then the collected organic phase was dried over anhydrous $MgSO_4$. The crude product was obtained by evaporation of the organic solvent, which was further recrystallized with CH_2Cl_2 and *n*-hexane to obtain allyl ester as white solid.

Allyl 3α,7α,12α-trihydroxy-5β-cholan-24-oate (**1a**): White solid, yield: 97%; ^{1}H NMR (300 MHz, $CDCl_3$): δ 0.67 (s, 3H, 18-CH_3), 0.88 (s, 3H, 19-CH_3), 0.98 (d, J=5.82 Hz 3H, 21-CH_3), 0.99–2.80 (m, 24H, steroidal skeleton H), 3.44 (m, 1H, 3β-CH), 3.83 (s, 1H, 7β-CH), 3.95 (s, 1H, 12β-CH), 4.56 (d, J=5.82 Hz, 2H, OCH_2), 5.20-5.33 (m, 2H, terminal allyl H), 5.80-6.00 (m, 1H, *CH*=CH_2); ^{13}C NMR (75 MHz, $CDCl_3$): δ 12.59, 17.42, 22.57, 23.30, 26.55, 27.58, 28.31, 30.52, 30.96, 31.34, 34.77, 34.85, 35.33, 39.60, 41.55, 46.56, 47.15, 65.06, 68.55, 72.04, 73.16, 118.21, 132.41, 174.08; ESI-MS(-): *m/z* 483.8 $[M+Cl]^-$.

Allyl 3α, 12α-dihydroxy-5β-cholan-24-oate (**1b**): White solid, yield: 98%; ^{1}H NMR (300 MHz, $CDCl_3$): δ 0.67 (s, 3H, 18-CH_3), 0.90 (s, 3H, 19-CH_3), 0.97 (d, J=6.18 Hz 3H, 21-CH_3), 0.92–2.50 (m, 26H, steroidal skeleton H), 3.61 (m, 1H, 3β-CH), 3.97 (s, 1H, 12β-CH), 4.56 (d, J=5.49 Hz, 2H, OCH_2), 5.20-5.34 (m, 2H, terminal allyl H), 5.80-6.00 (m, 1H, *CH*=CH_2); ^{13}C NMR (75 MHz, $CDCl_3$): δ 12.83, 17.41, 23.25, 23.72, 26.21, 27.21, 27.53, 28.77, 30.60, 30.96, 31.33, 33.76, 34.20, 35.16, 35.29, 36.13, 36.54, 42.17, 46.59, 47.43, 48.36, 60.06, 71.90, 73.23, 118.20, 132.43, 173.96; ESI-MS(-): *m/z* 468.2 $[M+Cl]^-$.

Compounds 2a and 2b: To a solution of terminal allyl cholate (15 mM) and dry K_2CO_3 (4.15 mg, 30 mM) in 50 mL dry dichloromethane, 4-bromobutyryl chloride (2.13 mL, 18.4 mM) in 10 mL dry dichloromethane was added

dropwisely at 0 °C. The reaction mixture was allowed to stir at room temperature for 12 h. The crude mixture was filtered through a short column of silica gel to remove the insoluble material. The filtrate was extracted with 10% critic acid and brine, dried over anhydrous $MgSO_4$. The crude organic material was purified by silica gel column chromatograph to afford target molecular.

Allyl 3α-bromobutoxyl-7α,12α-dihydroxy-5β-cholan-24-oate (**2a**): Yellow waxy solid, yield: 71%; ^{1}H NMR (300 MHz, $CDCl_3$): δ 0.69 (s, 3H, 18-CH_3), 0.90 (s, 3H, 19-CH_3), 0.99 (d, *J*=6.18 Hz, 3H, 21-CH_3), 0.99–2.50 (m, 26H, steroidal skeleton H), 3.44 (t, 2H, *J*=6.18 Hz, -$OCOCH_2$), 3.85 (br, 1H, 7β-CH), 3.98 (br, 1H, 12β-CH), 4.48-4.70 (m, 3H, 3β-CH, $COOCH_2$), 5.20-5.34 (m, 2H, terminal allyl H), 5.80-6.00 (m, 1H, *CH*=CH_2); ^{13}C NMR (75 MHz, $CDCl_3$): δ 12.63, 17.45, 22.59, 23.25, 26.76, 27.53, 27.97, 28.42, 30.92, 31.30, 32.90, 33.02, 34.46, 34.77, 34.94, 35.24, 39.59, 41.28, 42.10, 46.64, 47.33, 65.08, 68.36, 73.03, 76.64, 118.23, 132.39, 172.19, 173.98; ESI-MS (-): *m/z* 633.4 $[M+Cl]^-$.

Allyl 3α-bromobutoxyl 12α-hydroxy-5β-cholan-24-oate (**2b**): Yellow waxy solid, yield: 69%; ^{1}H NMR (300 MHz, $CDCl_3$): δ 0.68 (s, 3H, 18-CH_3), 0.91 (s, 3H, 19-CH_3), 0.97 (d, J=6.18 Hz, 3H, 21-CH_3), 0.99–2.50 (m, 26H, steroidal skeleton H), 3.44 (m, 2H, -$OCOCH_2$), 3.99 (br, 1H, 12β-CH), 4.57 (m, 2H, $COOCH_2$), 4.73 (m, 1H, 3β-CH), 5.20-5.34 (m, 2H, terminal allyl H), 5.80-6.00 (m, 1H, *CH*=CH_2); ^{13}C NMR (75 MHz, $CDCl_3$): δ 12.83, 17.42, 23.20, 23.69, 26.10, 26.61, 27.03, 27.51, 27.94, 28.80, 30.95, 31.30, 32.25, 32.86, 32.98, 33.73, 34.20, 34.94, 35.13, 36.06, 41.95, 46.57, 47.43, 48.35, 65.06, 73.18, 74.67, 118.20, 132.41, 172.14, 173.93; ESI-MS (-): *m/z* 617.3 $[M+Cl]^-$.

Compounds 3a and 3b: To a stirred solution of **2** (1.67 mmol) in 4 mL freshly distilled Tetrahydrofuran (THF) was cooled to -10 °C, and hexamethyldisilathiane (358 mg, 2 mmol) and tetrabutylammonium fluoride (480 mg, 1.84 mmol) in 1.8 mL THF with 5% water were added. The resulting reaction mixture was allowed to warm to room temperature while being stirred for 20 min. The reaction mixture was then quickly poured into a saturated ammonium chloride solution. The resulting solution was extracted by ethyl acetate (10 mL×3). The combined organic solutions were washed with brine, dried over $MgSO_4$ and then concentrated by rotary evaporation to give the crude product, which was further purified by silica gel column chromatograph.

Allyl 3α-thiobutoxyl-7α,12α-dihydroxy-5β-cholan-24-oate (**3a**): Yellow waxy solid, yield: 62%; IR (KBr pellets), ν (cm^{-1}): 3672-3196 (-OH stretching), 3087 (=CH_2 stretching), 3042-2770 (alkyl CH, CH_2 stretching), 1730 (C=O stretching), 1648 (C=C stretching); ^{1}H NMR (300 MHz, $CDCl_3$): δ 0.66 (s, 3H, 18-CH_3), 0.88 (s, 3H, 19-CH_3), 0.96 (d, *J*=5.82 Hz, 3H, 21-CH_3), 0.97–2.50 (m, 26H, steroidal skeleton H), 3.83 (br, 1H, 7β-CH), 3.96 (br, 1H, 12β-CH), 4.40-4.70 (m, 3H, 3β-CH, $COOCH_2$), 5.15-5.40 (m, 2H, terminal allyl H), 5.80-6.00 (m, 1H, *CH*=CH_2); ^{13}C NMR (75 MHz, $CDCl_3$): δ 12.59, 17.44, 22.54, 23.27, 24.11, 26.62, 26.80, 27.57, 28.32, 29.22, 30.91, 31.30, 33.20, 34.58, 34.79, 34.98, 35.30, 39.49, 41.29, 41.99, 46.62, 47.30, 65.07, 68.39, 73.11, 74.32, 74.53, 118.20, 132.37, 172.65, 174.05; ESI-MS (-): *m/z* 586.8 $[M+Cl]^-$.

Allyl 3α-thiobutoxyl 12α-hydroxy-5β-cholan-24-oate (**3b**): Yellow waxy solid, yield: 59%; IR (KBr pellets), ν (cm^{-1}): 3630-3391 (-OH stretching), 3083 (=CH_2 stretching), 3041-2789 (alkyl CH, CH_2 stretching), 1731 (C=O stretching), 1647 (C=C stretching); ^{1}H NMR (300 MHz, $CDCl_3$): δ 0.68 (s, 3H, 18-CH_3), 0.92 (s, 3H, 19-CH_3), 0.98 (d, J=6.18 Hz, 3H, 21-CH_3), 0.93–2.65 (m, 26H, steroidal skeleton H), 3.99 (br, 1H, 12β-CH), 4.57 (m, 2H, $COOCH_2$), 4.72 (m, 1H, 3β-CH), 5.20-5.35 (m, 2H, terminal allyl H), 5.86-6.00 (m, 1H, *CH*=CH_2); ^{13}C NMR (75 MHz, $CDCl_3$): δ 12.82, 17.42, 23.20, 23.68, 24.09, 26.10, 26.62, 27.03, 27.51, 28.81, 29.23, 30.95, 31.30, 32.26, 33.17, 33.74, 34.20, 34.95, 35.13, 36.06, 41.95, 46.58, 47.43, 48.35, 65.05, 73.17, 74.66, 118.19, 132.40, 172.59, 173.92; ESI-MS (-): *m/z* 570.9 $[M+Cl]^-$.

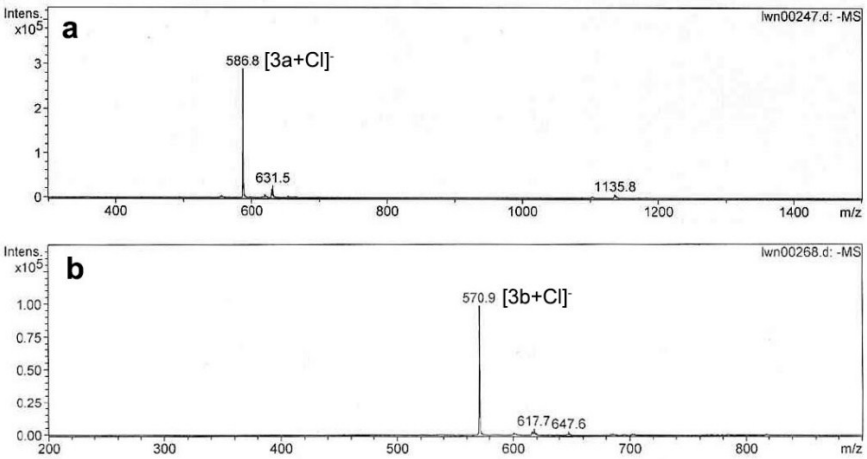

Fig. S1 ESI-MS spectra of compound **3a** (a) and **3b** (b).

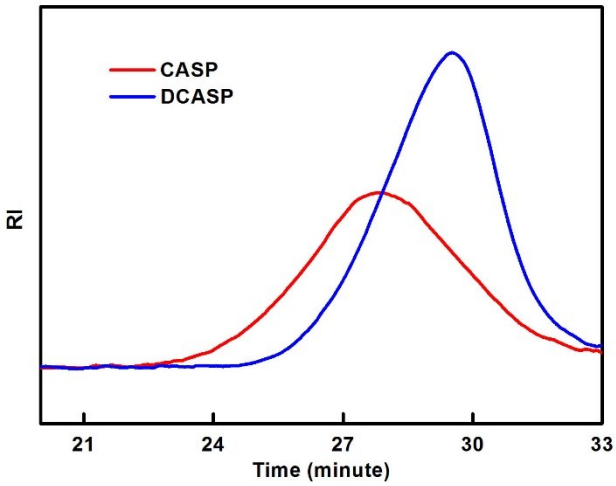

Fig. S2 GPC traces of the obtained main chain poly(bile acid)s **CASP** and **DCASP**.

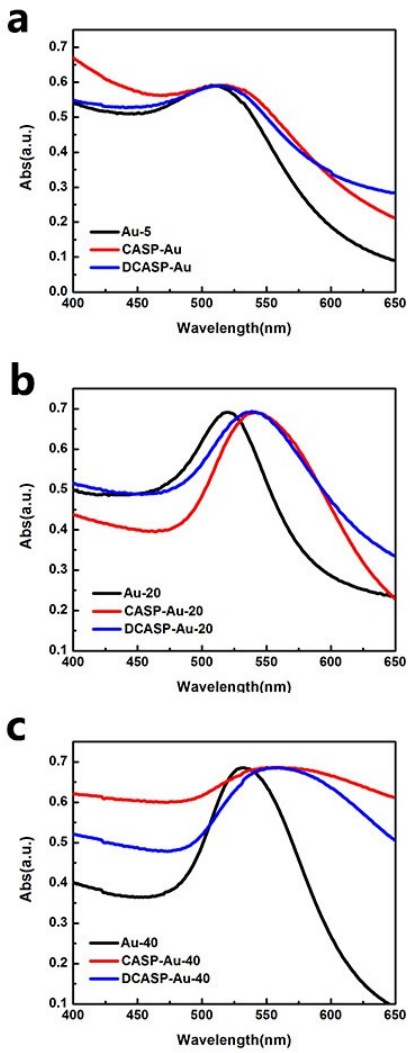

Fig. S3 The UV-vis spectra of poly(bile acid)s directed assemblies of GNPs with different size.

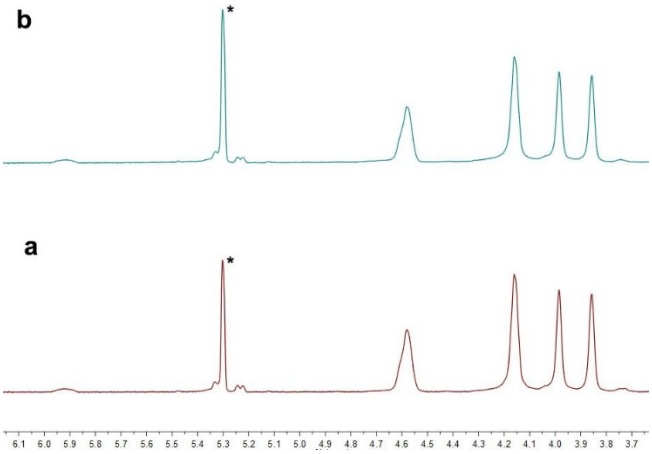

Fig. S4 The partial ^{1}H NMR spectra of polymer **CASP** in $CDCl_3$ before (a) and after irradiated by the NIR laser for 4 min (b). The signals with asterisk represent the solvent residual peaks.