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Supporting information

Chondroitin sulfate-enriched Hierarchical Multichannel

Polydopamine Nanoparticles with Ultrahigh Sorption Capacity for

Separation of Low-density Lipoprotein

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Chemicals and reagents.

Dopamine hydrochloride, 1,3,5-trimethyl benzene (TMB), Pluronic F127 and P123, ethanol, and ammonium hydroxide (NH₃·H₂O, 25-28%) are provided by Sinopharm Chemical Reagent Co., Ltd (Shanghai, China). N-(3-(dimethylamino) propyl)-N'ethyl carbodiimide hydrochloride (EDC·HCl, 98%), N-Hydroxysuccinimide (NHS, 98%), 2-(N-morpholino) ethanesulfonic acid monohydrate (MES·H₂O, 99%) and (3aminopropyl) triethoxysilane (APTES, \geq 99%) are purchased from Aladdin (Shanghai, China). Chondroitin sulfate (CS) is obtained from Shanghai Yuanye Biotechnology Co., Ltd. (Shanghai, China). Human Low-density lipoprotein (LDL) is purchased from Yiyuan Biotech (Guangzhou, China). Bovine serum albumin (BSA, A3311, 98%), β -lactoglobulin (β -Lg, L39008, 90%), and α -lactalbumin (a-LA, M1882, 90%) are purchased from Sigma-Aldrich (St. Louis, USA). Human serum samples are provided by a healthy volunteer. All reagents are used without further purification. Deionized (DI) water of 18 M Ω is used in all experiments.



Figure S1. FTIR spectrum of HMPDA-A-CSs nanoparticles containing various amounts of CSs (3, 5, 10, 15, 20, and 25 mg)



Figure S2. Adsorption isotherm of LDL by HMPDA-A-CS15 nanoparticles at pH 5.5 (a) and plot of $1/Q_e$ versus $1/C_e$ (b).



Figure S3. CD spectra (a) and fluorescence spectra (b) of the standard LDL solution and recovered LDL with the HMPDA-A-CS15.

Adsorbent	Adsorption Capacity (µg mg ⁻¹)	Interference	Ref.	Adsorption functional groups/molecules
Fe ₃ O ₄ -PM ₁ S ₁	7	BSA	1	Saccharide and sulfonate units
Heparin immobilized Cellulose Gel beads	79.1	HDL	2	Sulfonic groups and carboxyl groups
Carrageenan Based Heparin Mimetic Gel Beads	18.15	BSA and BFG	3	Polysaccharide structure, sulfonic and carboxyl groups
Sulfonated CNTs/activated carbon composite beads	10.46	Not clear	4	Sulfonic groups and carboxyl groups
MNPs@CS@Hep	1.04	HDL and total cholesteol	5	Heparin and chitosan
HMPDA-A-CS15	1015.2	BSA,α-LA,β-Lg	This work	Polysaccharide structure and sulfonic groups

Table S1. Adsorption capacities for LDL with various adsorbents

LDL original	The percentage of	The percentage of	The recovery
concentration (μg	cholesterol before	cholesterol after	percentage
mL⁻¹)	adsorption/desorption	adsorption/desorption	
	process	process	
5	63.3%	57.4%	90.7%
10	57.8%	50.0%	86.5%
15	52.8%	52.0%	98.5%

 Table S2. The recovery of cholesterol measured with Phosphorus-sulphur-iron method.

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