## Supplementary Information

## Hierarchically porous composite microparticles from microfluidics for controllable drug

## delivery

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Fig. S1 (a) Scanning electron microscopy (SEM) image of hollow mesoporous silica nanoparticles (HMSNs). The scale bar is 1  $\mu$ m. (b,c) Transmission electron microscopy (TEM) images of HMSNs and drug-loaded HMSNs respectively. The scale bars are 100 nm.



Fig. S2 The relations between the flow rates of outer phase and the number of encapsulated cores. The flow rate of middle phase was maintained at 0.5 ml/h, and the flow rate of inner phase was set as 0.05, 0.15, and 0.25 ml/h respectively.



Fig. S3 (a–e) Optical microscopy images of the double emulsions with zero, one, two, three and four cores, respectively. The scale bar is 300  $\mu$ m. (f–j) The size distributions of the double emulsions with zero, one, two, three and four cores, respectively. (k–o) Optical microscopy images of the solidified microparticles with zero, one, two, three, and four openings, respectively. The scale bar is 100  $\mu$ m.



Fig. S4 The layer by layer confocal laser scanning photographs of microparticles encapsulating a model drug with blue fluorescence and a model drug with red fluorescence simultaneously. The scale bar is  $50 \,\mu$ m.

Table S1 The fitting parameters for the drug release data from microparticles with various openings using Korsmeyer-Peppas model.

Number of openings on microparticle	k	n	R <sup>2</sup>
None	0.249	0.300	0.992
One	0.312	0.272	0.990
Тwo	0.409	0.216	0.958
Three	0.465	0.187	0.911
Four	0.471	0.192	0.926

k, release constant; n, diffusion exponent; R<sup>2</sup>, correlation coefficient



Fig. S5 (a, b) Bilateral ventrolateral partial thickness abdominal wall defects were created. The musculoskeletal defect was created by excising the external and internal oblique layers of the abdominal wall, leaving the transversalus fascia intact. (c) Different scaffolds were implanted into the defect site and secured with Prolene sutures at each of the four corners. The scale bar is 2 cm.



Fig. S6 Immunostaining for Hif-1 $\alpha$  of PADM, HPMs-PADM and DFO-HPMs-PADM at 4- and 8weeks time points. The scale bar is 50  $\mu$ m.

Supplementary Movies

<u>Movie S1</u>: Recorded video of the generation process of emulsion templates without inner cores using a capillary microfluidic method. The movie plays seven times faster than real time.

<u>Movie S2</u>: Recorded video of the generation process of emulsion templates with single inner core using a capillary microfluidic method. The movie plays seven times faster than real time. <u>Movie S3</u>: Recorded video of the generation process of emulsion templates with two inner cores using a capillary microfluidic method. The movie plays seven times faster than real time.

<u>Movie S4:</u> Recorded video of the generation process of emulsion templates with three inner cores using a capillary microfluidic method. The movie plays seven times faster than real time.

<u>Movie S5:</u> Recorded video of the generation process of emulsion templates with four inner cores using a capillary microfluidic method. The movie plays seven times faster than real time.

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