## Supporting Information

# Positron Emission Tomography-Guided Photodynamic Therapy with Biodegradable Mesoporous Silica Nanoparticles for Personalized Cancer Immunotherapy

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# Supplementary Figures

(a)

| | Hydrodynamic size (nm) | Zeta potential (mV) | Pore size and volume | BET surface area ($m^2/g$) | Source |
|---|---|---|---|---|---|
| bMSN | 78 ± 23 | -29.5 ± 5.8 | 5 - 10 nm, 2.3 $cm^3/g$ | 608 | This study |
| MSN1 | 217 ± 75 | -22.4 ± 2.9 | 2 -4 nm, 0.90 $cm^3/g$ | 485 | Sigma-Aldrich |
| MSN2 | 171 ± 91 | -23.1 ± 4.1 | 2 - 4 nm, 0.93 $cm^3/g$ | 518 | NanoCom posix |

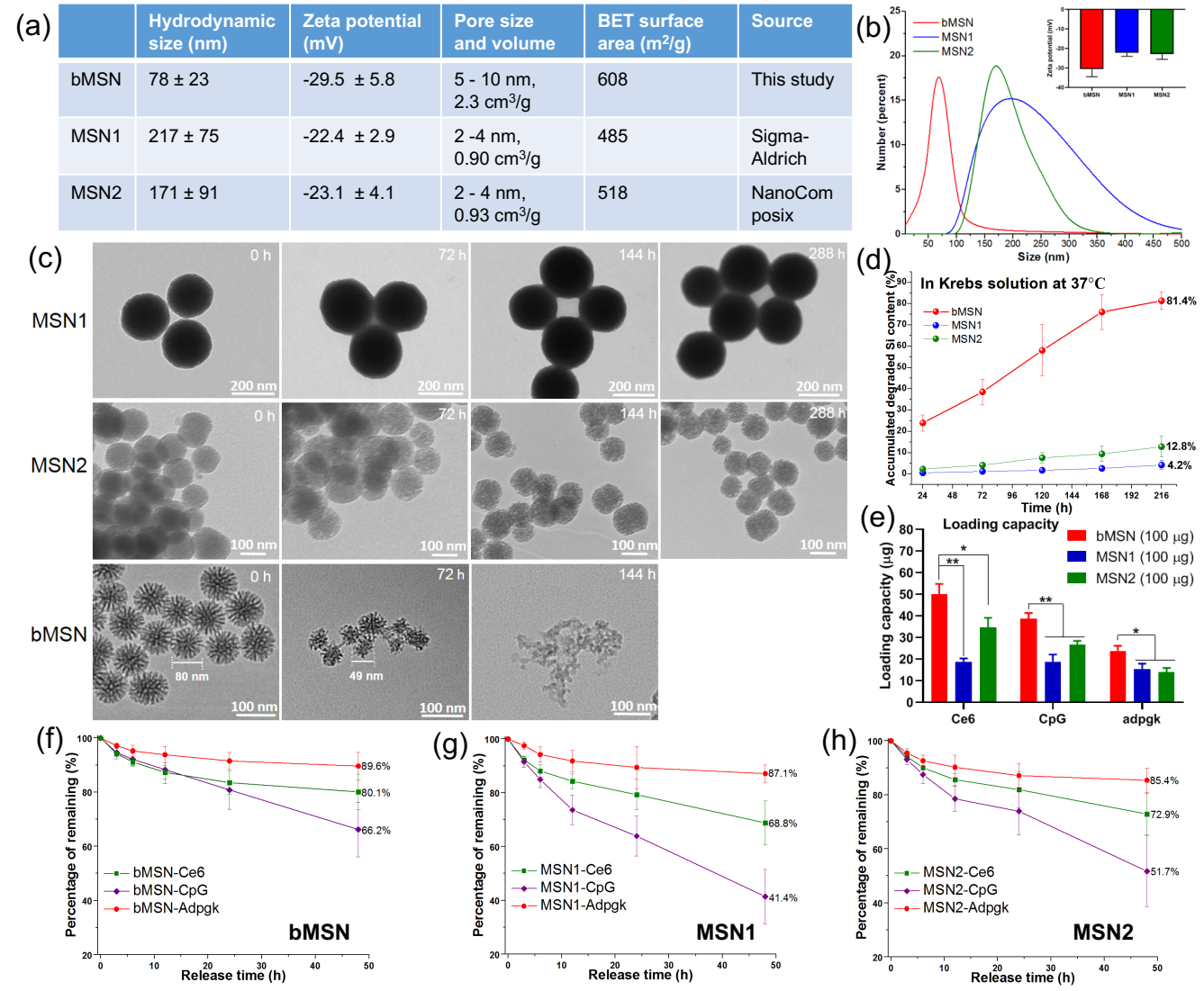



**Figure S1:** (a) Summary of average size, zeta potential, pore size, pore volume and BET surface area of bMSN, MSN1 and MSN2. (b) Size and surface zeta potential of bMSN, MSN1 and MSN2 measured by DLS. (c), (d) *in vitro* biodegradation profile of bMSN in simulated body fluid (Krebs solution) at 37 °C for 12 days. At indicated time points, TEM images (c) were obtained. (e) Loading capacity of bMSN, MSN1 and MSN2. Release profile of bMSN (f), MSN1 (g) and MSN2 (h) in PBS at room temperature.

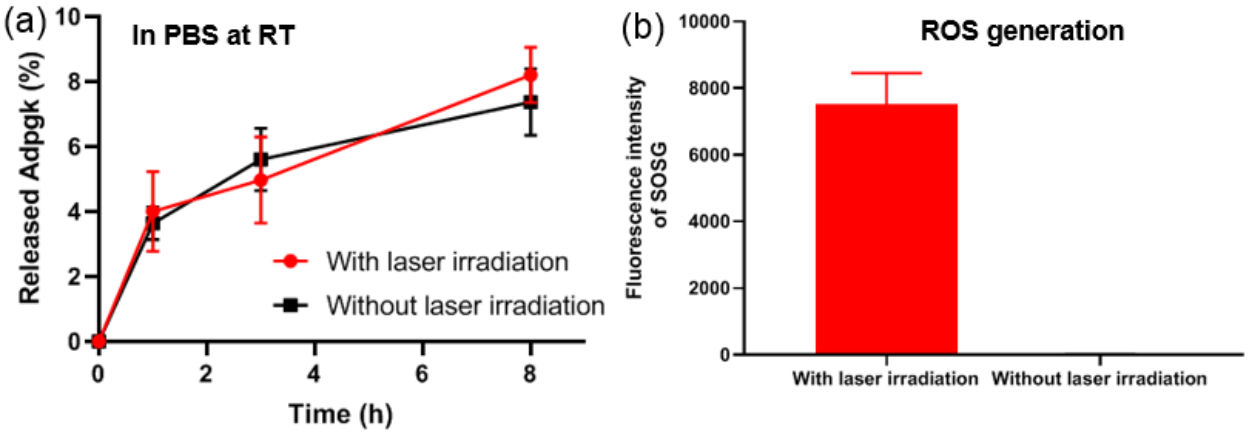



**Figure S2:** (a) Adpgk release profile from bMSN(CpG/Ce6)-Adpgk in PBS at room temperature after 20 min of laser irradiation (red line, 25 mW/cm$^2$) or without laser irradiation (black line). (b) After 20 min of irradiation, singlet oxygen produced by bMSN(Ce6/CpG)-Adpgk was measured by quantifying the changes in the fluorescence intensity of SOSG (Singlet Oxygen Sensor Green).

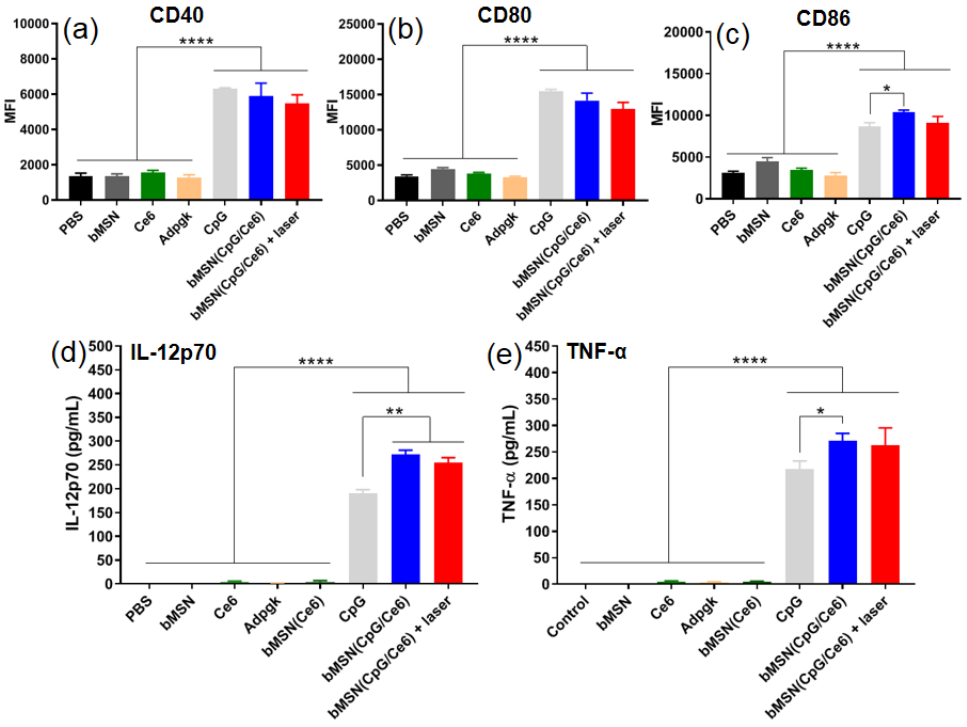



**Figure S3**. *In vitro* activation and cytokine secretion by BMDCs. CD40 (a), CD80 (b) and CD86 (c) expressions levels on BMDCs after incubation with bMSN (0.2 mg/mL), Ce6 (0.5 μg/mL), Adpgk (10 μg/mL), CpG (0.8 μg/mL) and bMSN (CpG (0.8 μg/mL)/Ce6(0.5 μg/mL)) with or without laser irradiation for 6 h, followed by fresh media exchange and 18 h culture. The expression levels of costimulatory markers were analyzed by flow cytometry. IL-12p70 (d) and TNF-α (e) secretion by BMDCs after incubation with bMSN (0.2 mg/mL), Ce6 (0.5 μg/mL), Adpgk (10 μg/mL), bMSN (Ce6 (0.5 μg/mL)), CpG (0.6 μg/mL) and bMSN (CpG (0.6 μg/mL)/Ce6 (0.5 μg/mL)) with or without laser irradiation for 6 h, followed by fresh media exchange and 18 h culture. Laser irradiation was performed with 660 nm laser at the power density of 10 mW/cm$^2$ for 2 min.

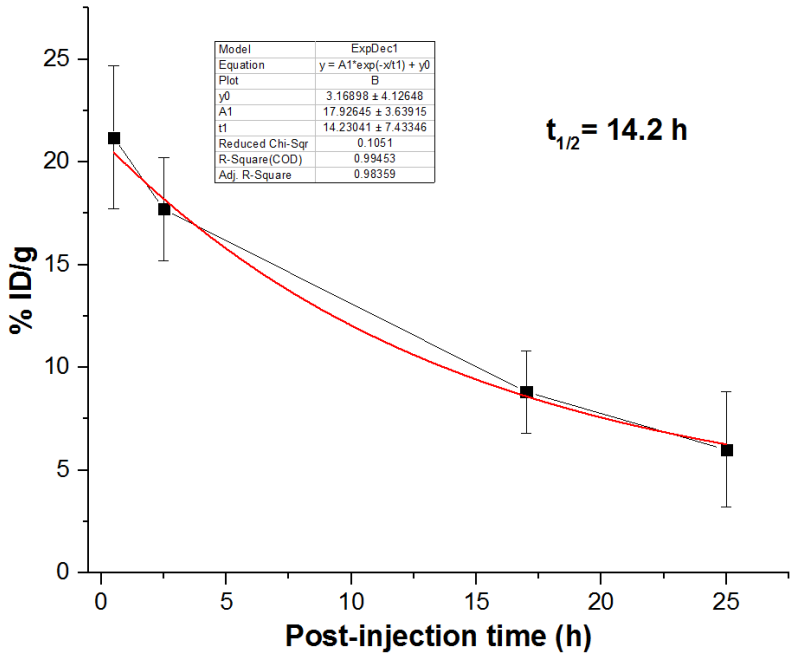



**Figure S4:** Time-dependent radioactive concentration of $^{64}$Cu-NOTA-bMSN(CpG/Ce6)-Adpgk in mouse blood (one-compartment fitting).

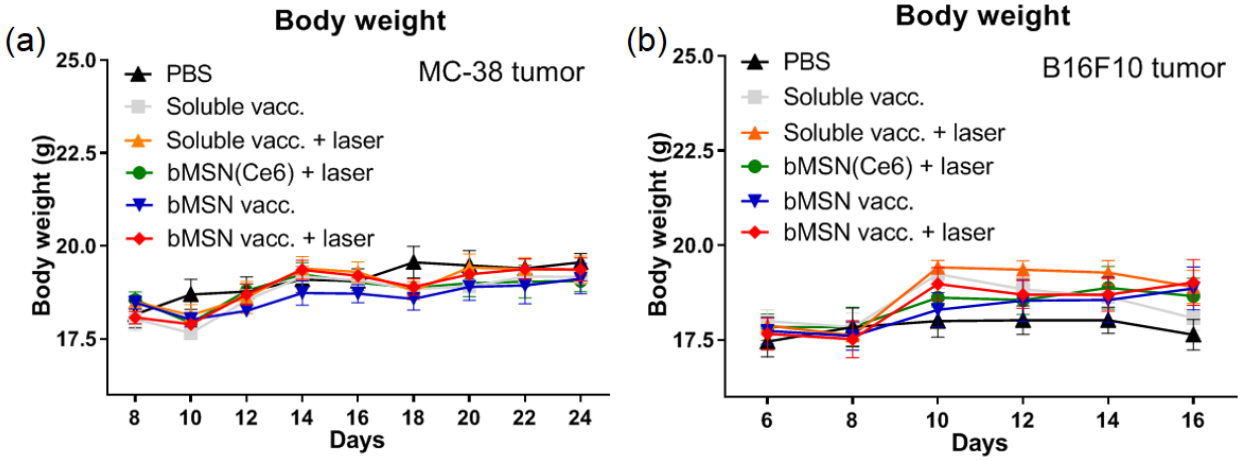
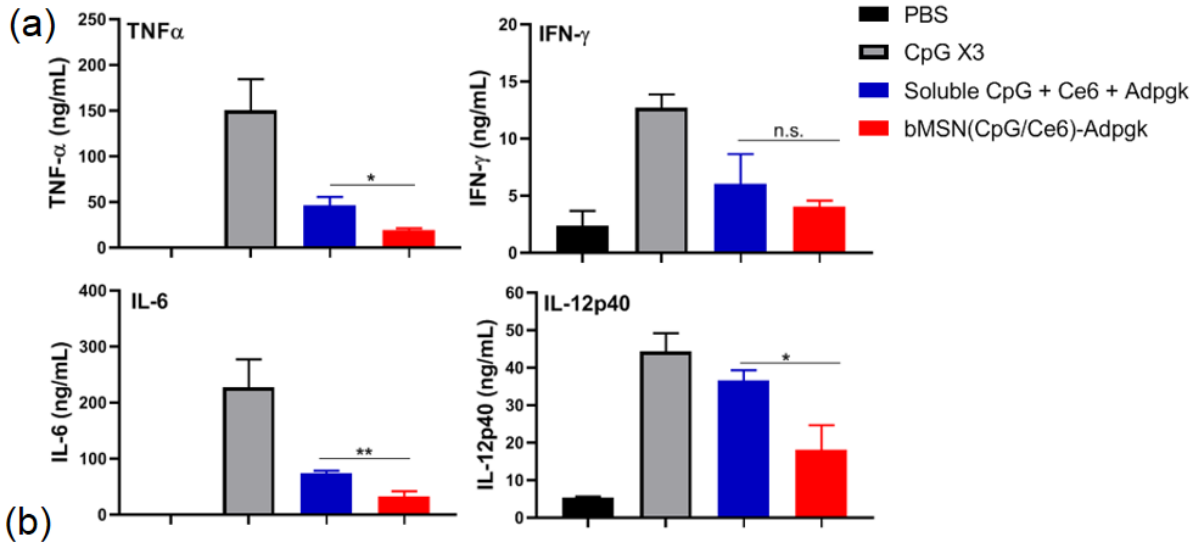



**Figure S5:** (a) Changes in the bodyweight of MC-38 tumor-bearing mice treated as shown in Figure 5. (b) Changes in the bodyweight of B16F10 tumor-bearing mice treated as shown in Figure 8.

(a)




(b)

| Name | Reference range | PBS | Soluble vaccine + laser | bMSN vaccine | bMSN vaccine + laser |
|---|---|---|---|---|---|
| AST, U/L | 39.6-386.1 | 35.0 ± 6.4 | 42.1 ± 8.9 | 39.6 ± 7.8 | 38.8 ± 8.1 |
| ALT, U/L | 24.3-115.3 | 29.3 ± 1.1 | 34.7 ± 5.1 | 38.5 ± 2.6 | 39.6 ± 9.7 |
| ALP, U/L | 65.5-364.2 | 116 ± 20.3 | 66.5 ± 11.3 | 93.7 ± 3.2 | 80.5 ± 12.3 |
| Triglyceride, mg/dL | 72.7-303.2 | 112.2 ± 13.2 | 102.5 ± 15.6 | 85.6 ± 14.6 | 90.7 ± 18.3 |
| Cholesterol, mg/dL | 60.2-167.3 | 72.3 ± 8.9 | 68.6 ± 9.6 | 71.8 ± 5.4 | 65.9 ± 7.3 |
| Glucose, mg/dL | 79.4-354.7 | 248 ± 25.4 | 215 ± 24.1 | 232 ± 12.2 | 219 ± 31.5 |
| Creatine phosphokinase, U/L | 22.0-198.0 | 54.7 ± 20.2 | 54.3 ± 24.6 | 71.6 ± 12.3 | 43.3 ± 10.8 |
| Blood urea nitrogen, mg/dL | 5.2-30.7 | 28.0 ± 4.5 | 27.3 ± 3.2 | 28.3 ± 1.5 | 22.7 ± 4.6 |

**Figure S6:** (a) Cytokine release in blood 2 h after i.v. injection of (1) PBS; (2) CpG (6 μg/g bodyweight); (3) soluble CpG (2 μg/g bodyweight) + Ce6 + Adpgk; (4) bMSN(CpG(2 μg/g bodyweight)/Ce6)-Adpgk. (b) Analyses of serum biochemical markers of each group on day 7 after the vaccination (i.v. injection).

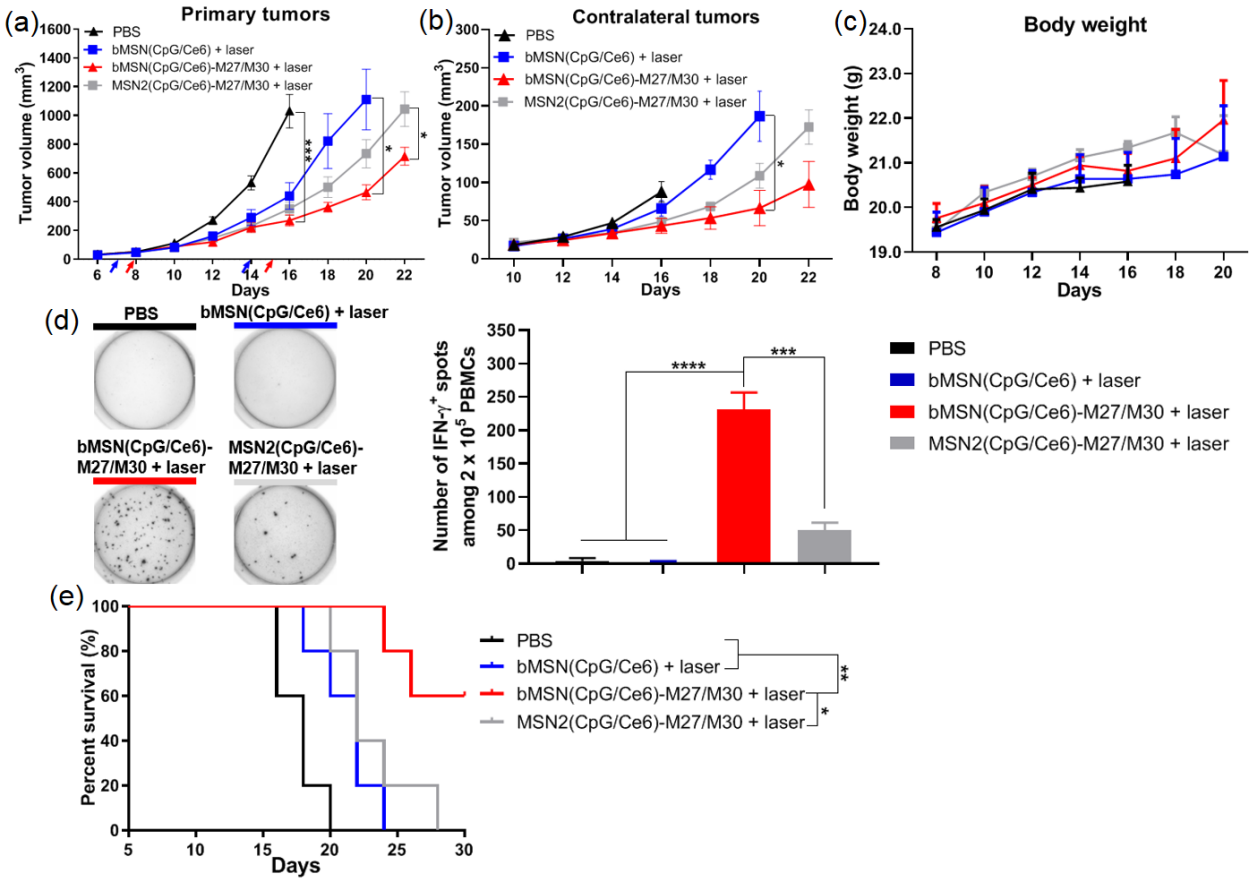



**Figure S7:** Anti-tumor therapy study in B16F10 tumor-bearing mice. C57BL/6 mice were randomly divided into the following 4 treatment groups: 1) PBS control; 2) bMSN(CpG/Ce6) with laser irradiation; 3) bMSN vaccine (bMSN(CpG/Ce6)-M27/M30) with laser irradiation; and 4) MSN2 vaccine (MSN(CpG/Ce6)-M27/M30) with laser irradiation. Laser irradiation (660 nm, 50 mW/cm$^2$ for 15 min) was conducted over the tumors at 24 h after each injection. (a), (b) Average primary and contralateral B16F10 tumor growth curves of each group. (c) The average body weight of mice. (d), IFN-γ ELISPOT (enzyme-linked immunospot) assay was performed by *ex vivo* re-stimulation of PBMCs (peripheral blood mononuclear cells) with M27 and M30 peptides (10 μg/mL) on day 7 after the prime vaccination. (e) Overall survival curves of each group.