Supporting Information**:**

Silver telluride nanoparticles as biocompatible and enhanced contrast agents for x-ray imaging: an *in vivo* breast cancer screening study

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Synthesis of 11-MUA coated silver telluride nanoparticles:

The protocol used to synthesize 11-mercaptoundecanoic acid (11-MUA) coated Ag_2Te NPs was similar to that of PEG-SH coated NPs. In brief, 1 mL of hydrazine hydrate was added to a 9 mL aqueous solution containing 30 mM of 11-MUA, 5 mM of Na_2TeO_3, and 10 mM of $AgNO_3$. The reaction was allowed to proceed for 30 minutes in an oil bath at 90 °C under magnetic stirring. Upon reaction completion, the solution placed on ice followed by three washes with DI water using 10 kDa ultrafiltration MWCO tubes at 4000 rpm.

Ag^+ ion release

The release of Ag^+ ions from Ag_2Te nanoparticles was assessed as described previously.[1, 2] In brief, the nanoparticles were incubated at 37 ºC in DI water or simulated lysosomal fluid (citrate buffer at pH 5) at a concentration of 1 mg/mL to a final volume of 5 mL. At each time point, the Ag^+ ions were separated by centrifugation using a 10 kDa MWCO tube. The Ag^+ released at each time point was measured via ICP-OES. Data is presented as mean ± standard deviation.

Fourier transform infrared (FT-IR) Spectroscopy

Samples were prepared by diluting 5 uL of the solutions of interest in 100 mg of potassium bromide. The samples were then dried in an oven, compacted into pellets and analyzed using JASCO FT/IR 480 Plus.

X-ray photoelectron spectroscopy (XPS)

XPS analysis was conducted using a PHI Veraprobe 5000 instrument equipped with monochromated AlK alpha source. The following parameters were used: X-ray setting was set to

200 microns, electron beam to 50W, while photoelectrons were collected using hemispherical analyzer. For survey scans, a pass energy of 117 V was used. Dual beam neutralization was performed to compensate depletion of photoelectrons from the surfaces as the charge compensation method.

Reactive oxygen species (ROS) generation

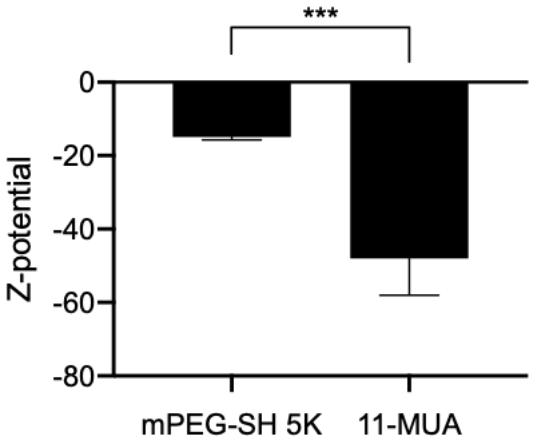
To quantify the generation of reactive oxygen species in J774A.1 cells (macrophages), a protocol, similar to that previously described by our group, was used.[2] In brief, 10,000 cells were plated in each well of a 96 well plate 24 hrs prior to the experiments. The cells were then treated with Ag_2Te, Ag_2S or Ag nanoparticles at concentrations ranging from 0-1 mg/mL for 4 hrs. After the treatment time, the cell monolayer was washed twice with PBS. 100 uL of CM-H2DCFDA (Invitrogen, Carlsbad, CA, USA) at a 10 mM concentration was then added to cells and incubated for 25 min. Cells were then washed once with PBS. 100 uL of PBS was added to each well before reading the fluorescence at an excitation and wavelength of 492 nm and 527 nm, respectively. 4 wells were counted as one sample, three independent experiments were done. Data is presented as mean % control ± standard deviation.

DNA damage

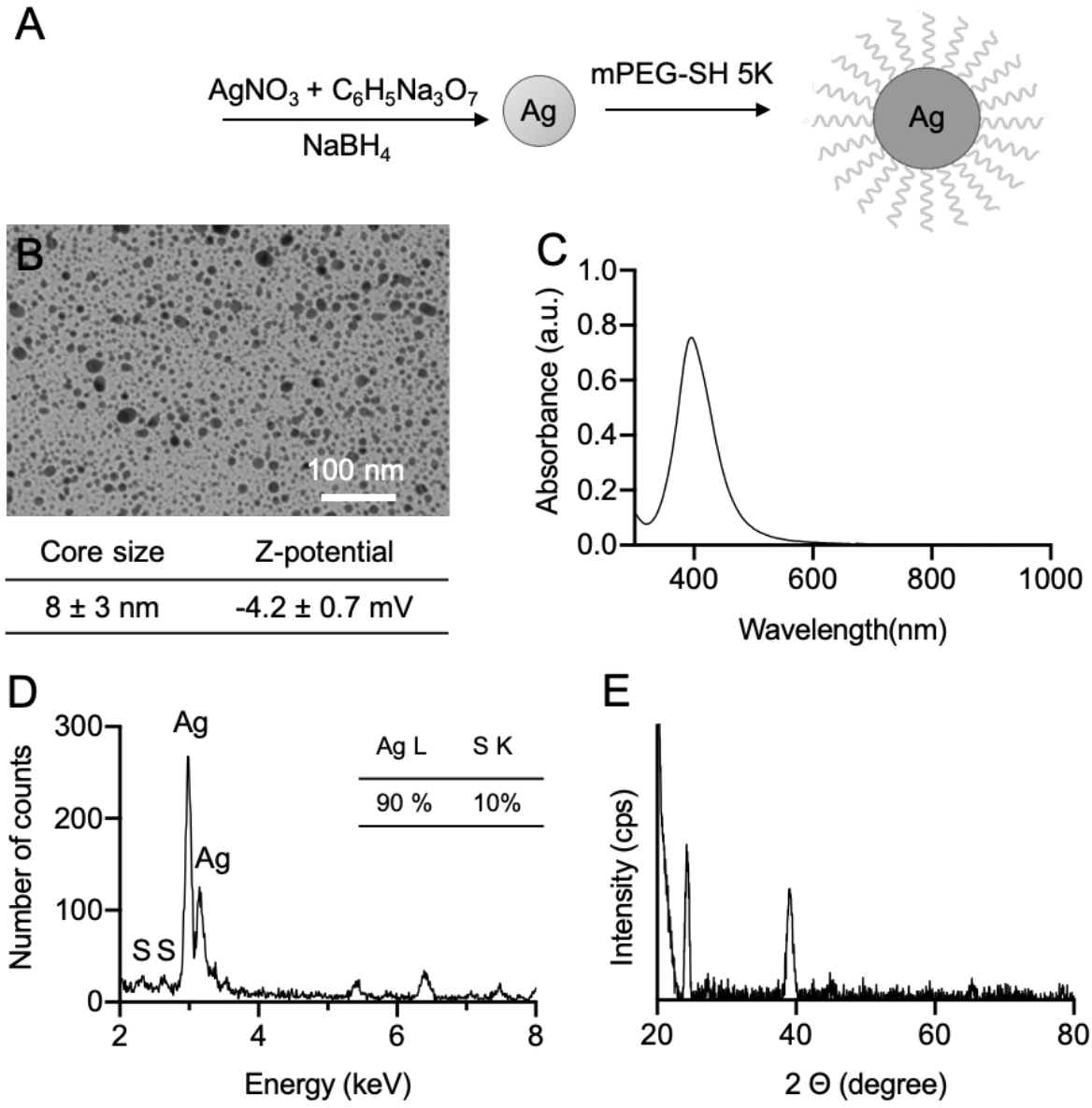
To quantify the DNA damage in cells after incubation with Ag_2Te, Ag_2S, and Ag nanoparticles, a previously described protocol was followed.[2] In brief, 1.5 x 10^6 cells were plated in 6 well plates 24 hrs prior to the experiment, following ATCC recommendations. The cells were then treated with the 3 different nanoparticles for 4 hrs at concentrations ranging from 0-1 mg/mL. After treatment, the cells were washed twice with PBS and trypsinized or scraped to collect the cells.

The DNA of these cells were extracted following the Genomic DNA Isolation Kit (ab65358) protocol from abcam (Cambridge, MA, USA).

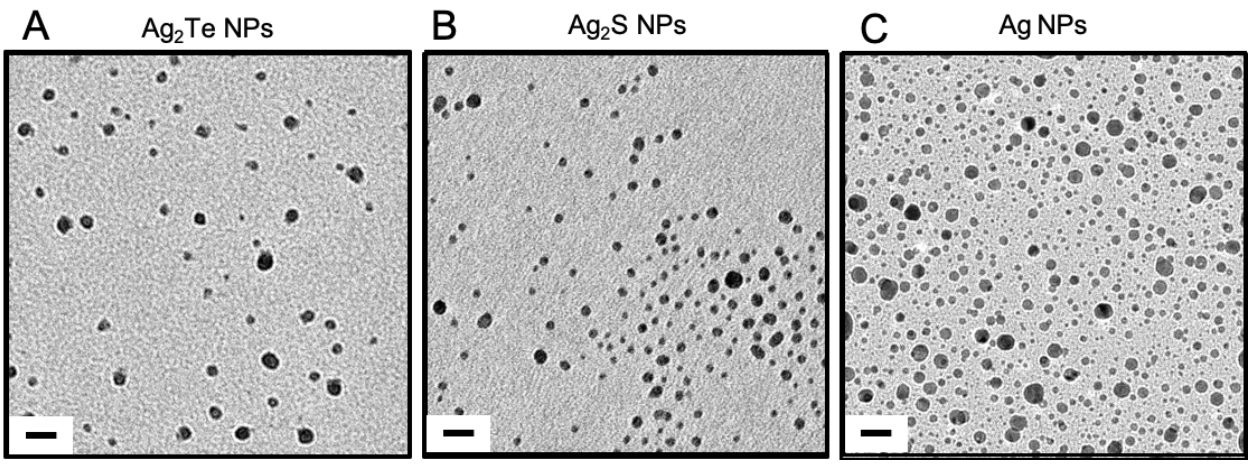
To quantify the DNA damage in the isolated DNA, the protocol for DNA Damage Assay Kit (ab211154) from abcam (Cambridge, MA, USA) was followed. This colorimetric test quantifies the apurinic/apyrimidinic (AP) sites, a marker of DNA damage. Data is presented as mean number of AP sites per 10^5 base pairs ± standard deviation.



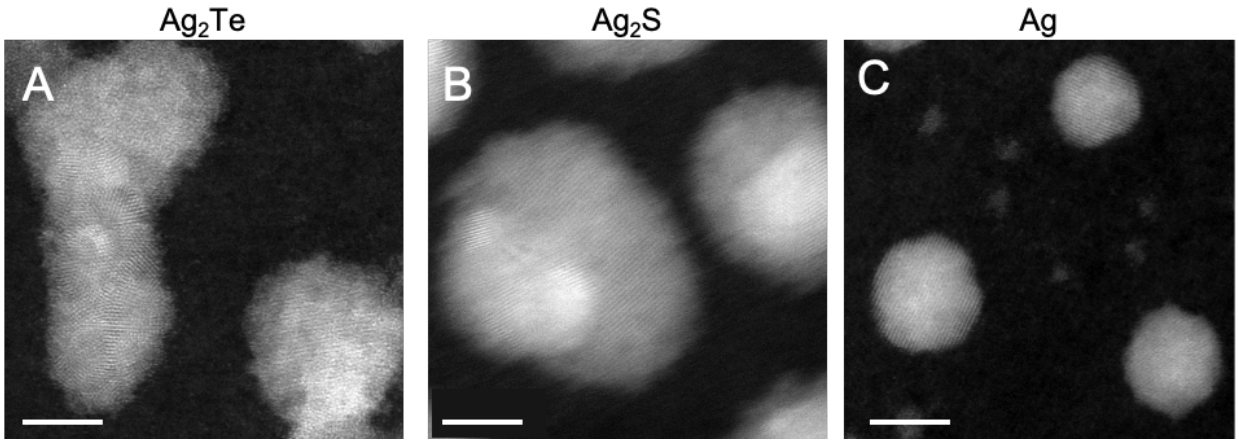
Supplemental Figure 1: Z-potential measurements of Ag_2Te nanoparticles coated with mPEG-SH 5K and 11- mercaptoundecanoic acid (11-MUA).



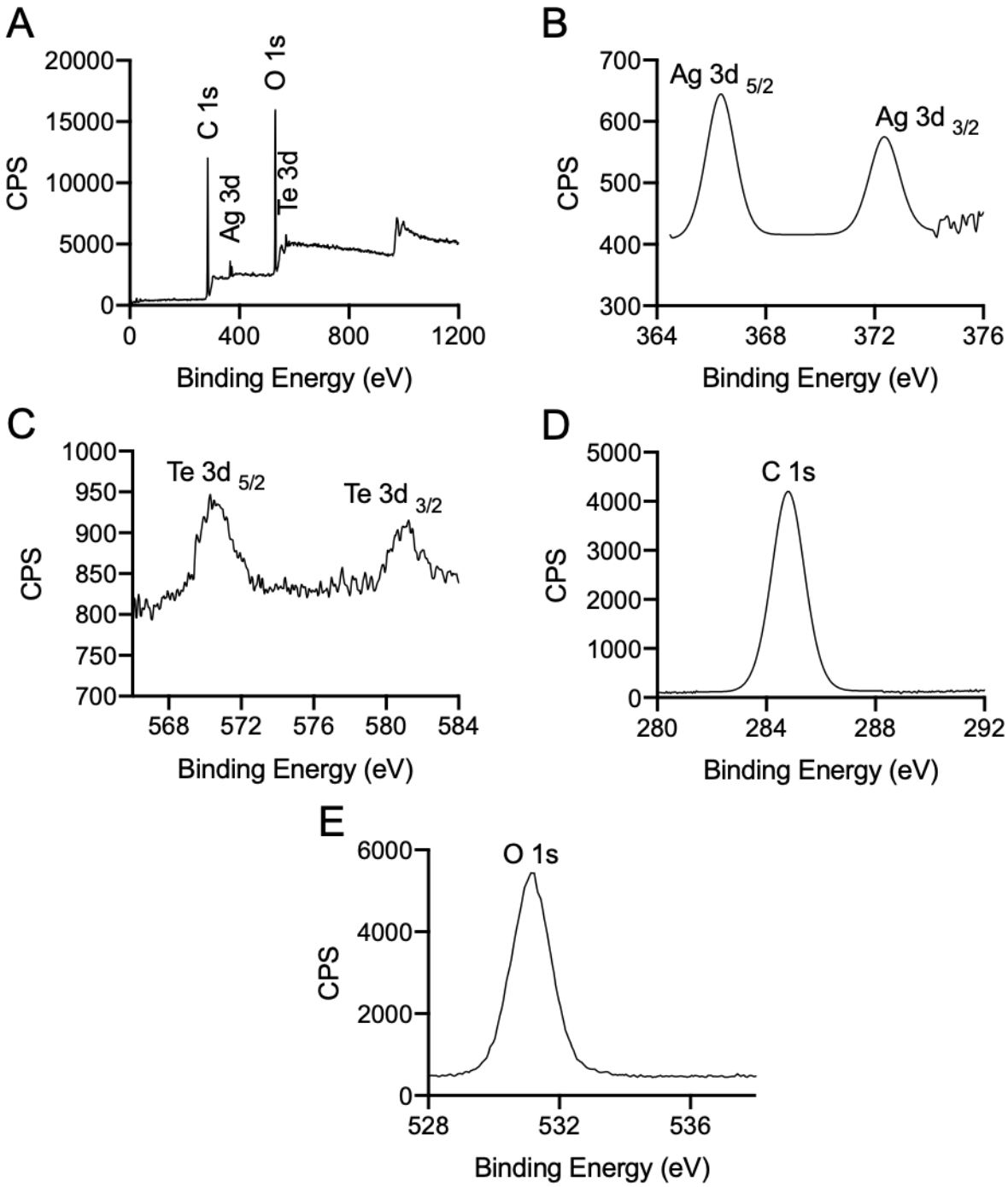
Supplemental Figure 2: Synthesis and characterization of Ag NPs. A) Schematic of Ag NP synthesis. B) TEM micrograph of Ag NPs, core size, and Z-potential data. C) UV-Vis spectrum of Ag NPs. D) Energy dispersive X-ray spectrum of Ag NPs. E) X-ray dispersive spectrum of Ag NPs.



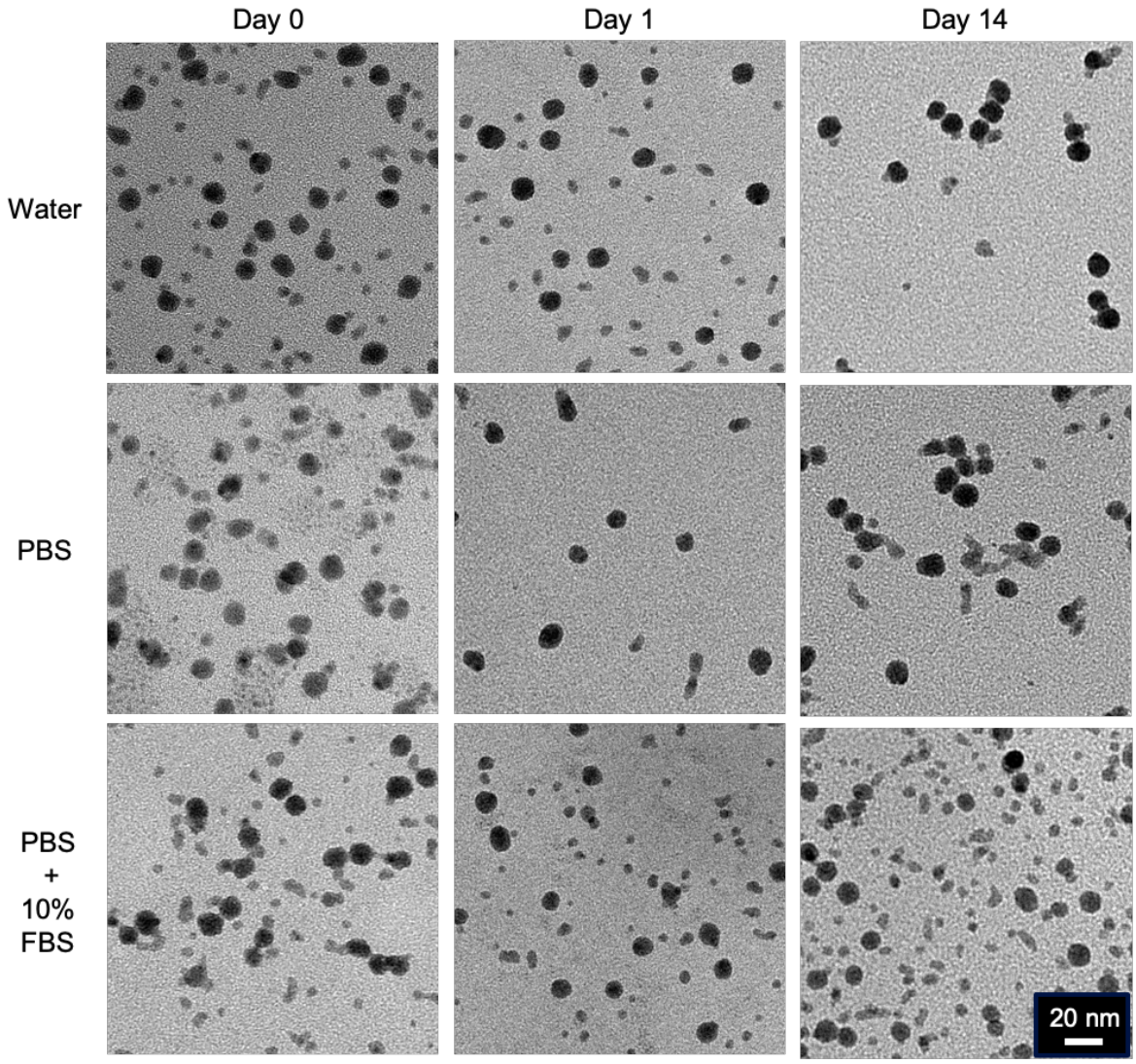
Supplemental Figure 3: TEM micrographs of mPEG-SH 5K coated A) Ag_2Te, B) Ag_2S, and C) Ag NPs. Scale size: 20 nm.



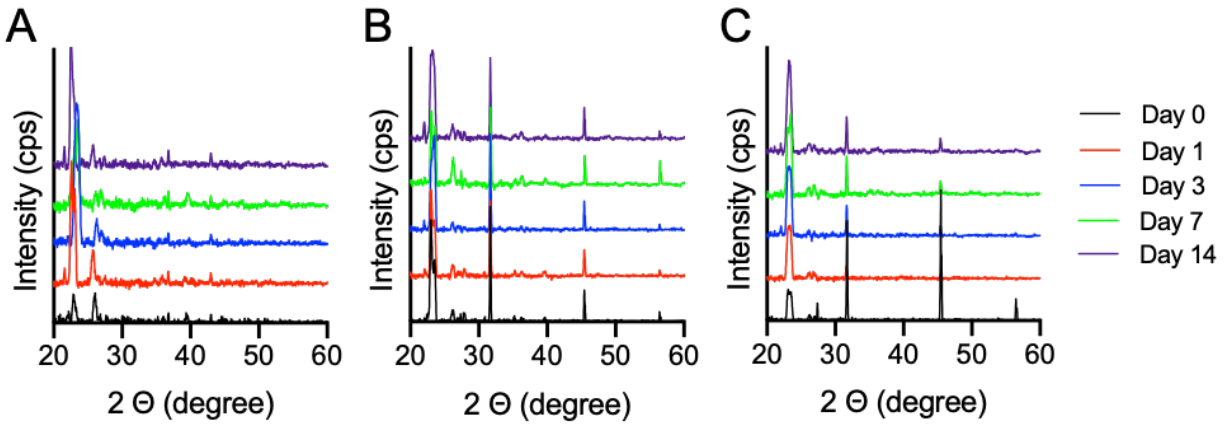
Supplemental Figure 4: High-resolution TEM micrographs of A) Ag_2Te, B) Ag_2S, and C) Ag NPs. Scale size: 5 nm.



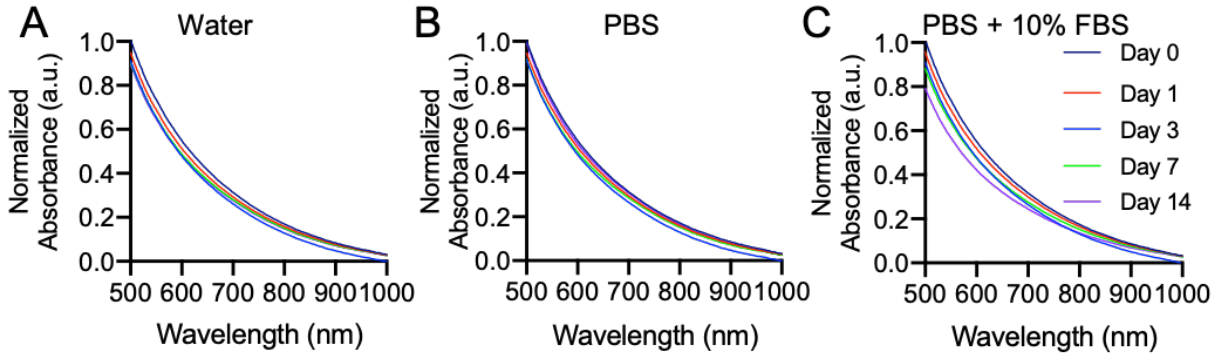
Supplemental Figure 5: XPS pattern of Ag_2Te nanoparticles. A) Survey spectrum. B) Ag 3d, C) Te 3d, D) C 1s, and E) O 1s high-resolution specta.



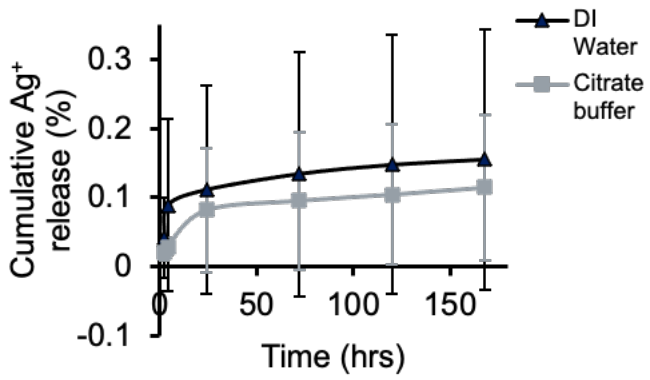
Supplemental Figure 6: TEM micrographs of Ag_2Te NPs coated with mPEG-SH 5K incubated for the time periods noted in different media (DI water, PBS, and PBS + 10% FBS).



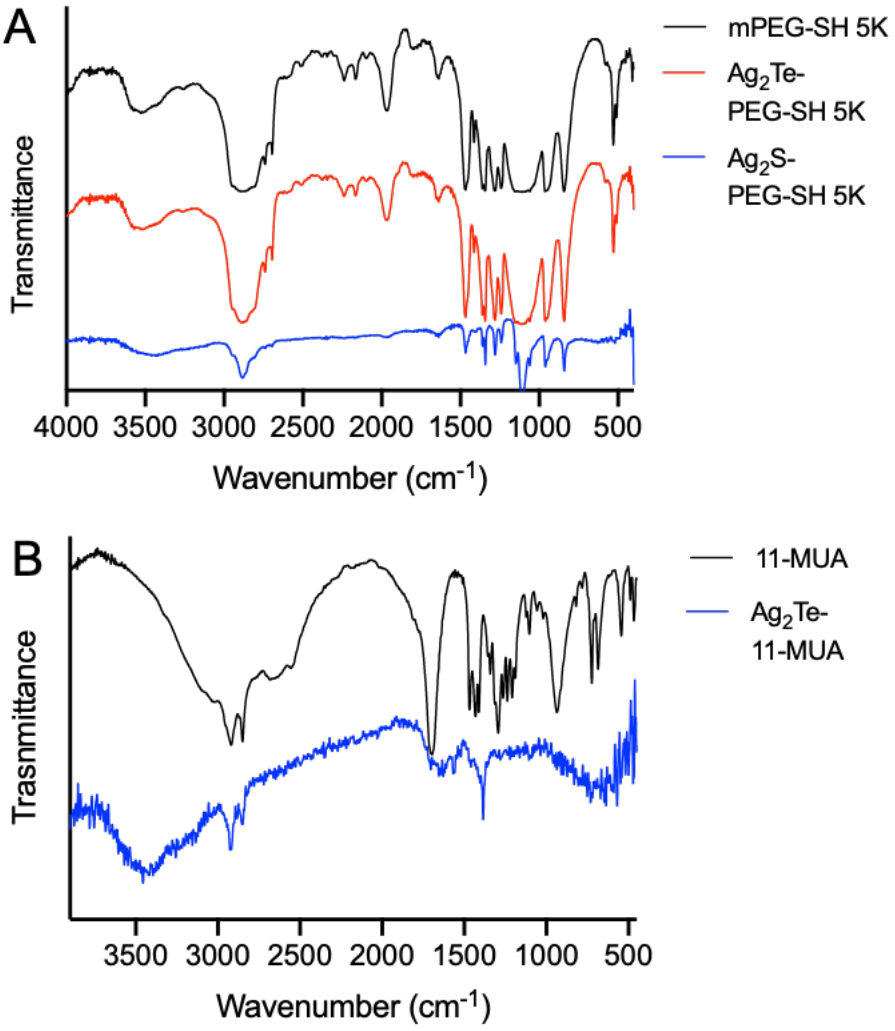
Supplemental Figure 7: XRD spectra of Ag_2Te NPs coated with mPEG-SH 5K incubated for the time periods noted in different media: A) DI water, B) PBS, and C) PBS + 10% FBS.



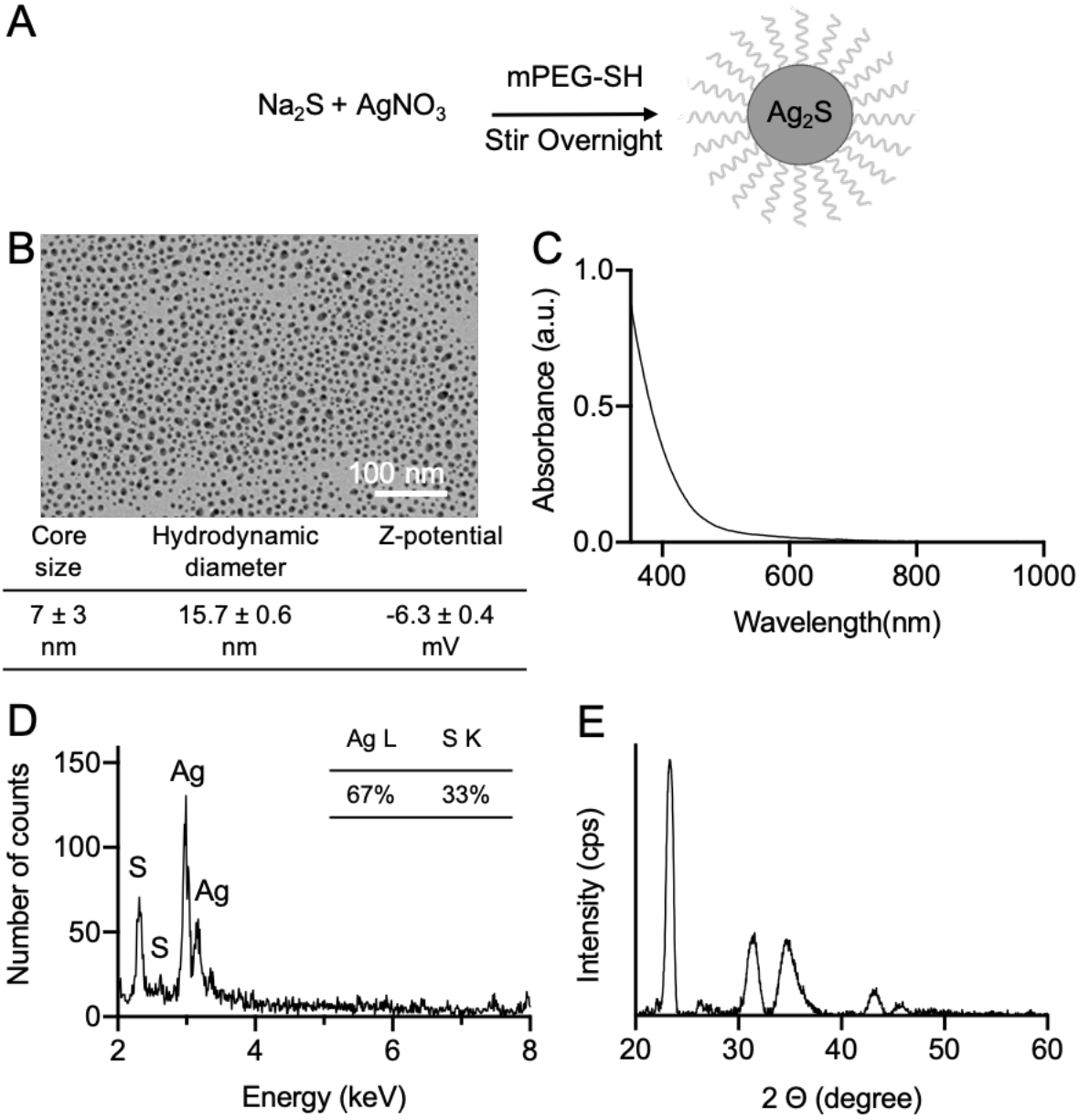
Supplemental Figure 8: UV-vis spectra of Ag_2Te NPs coated with 11-MUA over time in different media. NPs incubated in A) DI water, B) PBS, and C) PBS + 10% FBS.



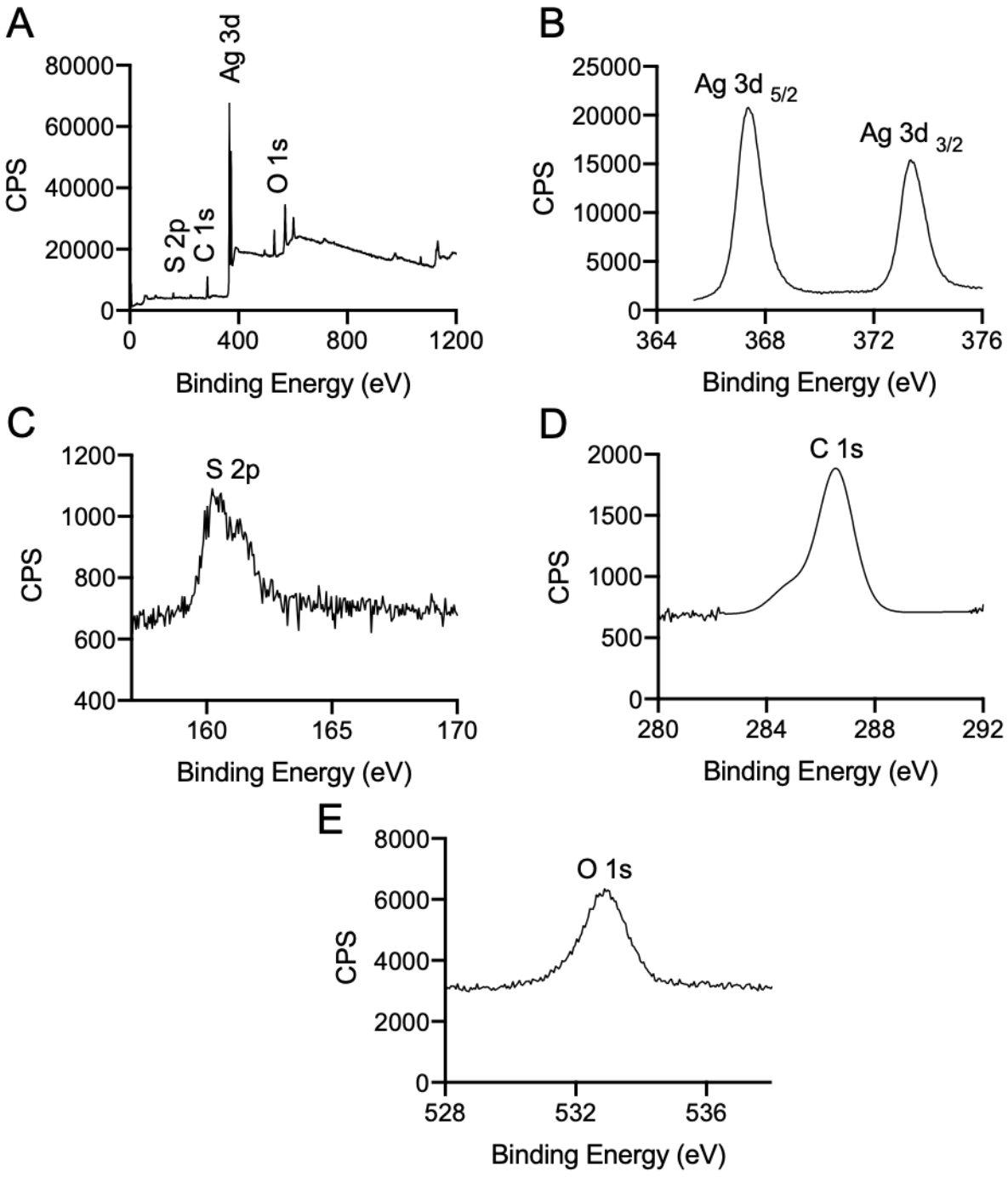
Supplemental Figure 9: Percentage of cumulative Ag^{+} ion release of Ag_2Te nanoparticles incubated in DI water and simulated lysosomal fluid (citrate buffer) over time.



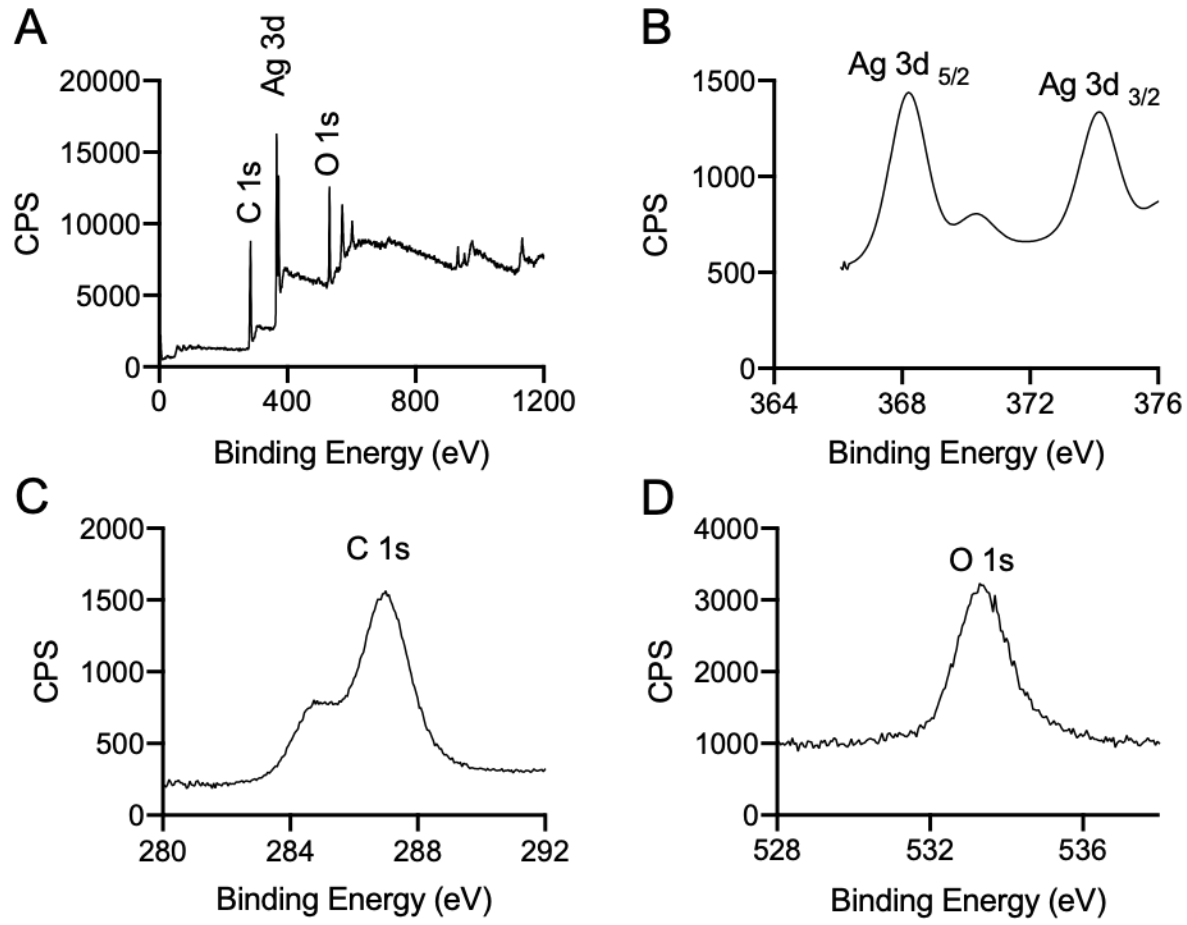
Supplemental Figure 10: A) FT-IR spectra of mPEG-SH 5K (black), Ag_2Te NPs coated with mPEG-SH 5K (red) and Ag_2S NPs coated with mPEG-SH 5K (blue). B) FT-IR spectra of 11-mercaptoundecanoic acid (11-MUA) (black) and Ag_2Te NPs (blue) coated with 11-MUA.



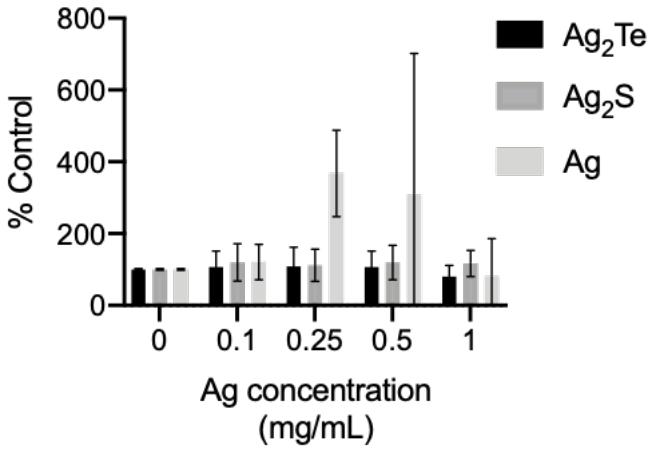
Supplemental Figure 11: Synthesis and characterization of Ag_2S NPs. A) Schematic of Ag_2S NP synthesis. B) TEM micrograph of Ag_2S NPs, core size, hydrodynamic diameter and Z-potential data. C) UV-Vis spectrum of Ag_2S NPs. D) Energy dispersive X-ray spectrum of Ag_2S NPs. E) X-ray dispersive spectrum of Ag_2S NPs.



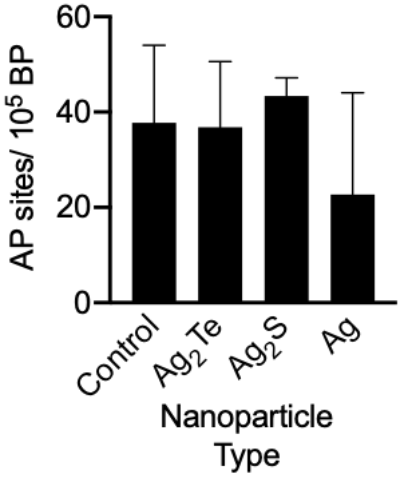
Supplemental Figure 12: XPS pattern of Ag_2S nanoparticles. Spectra showing A) survey scan, B) Ag 3d, C) S 2p, D) C 1s, and E) O 1s high-resolution spectra.



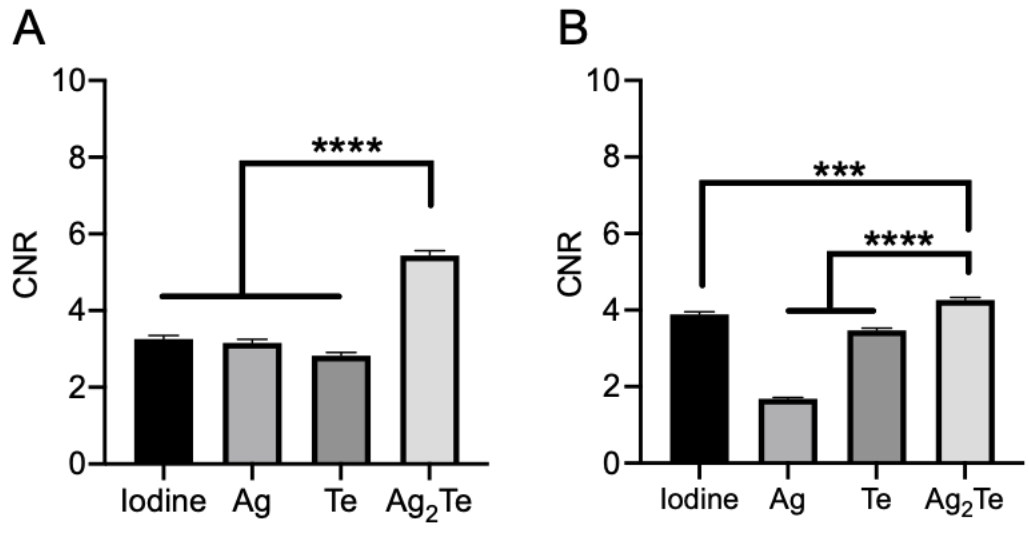
Supplemental Figure 13: XPS pattern of Ag nanoparticles. Spectra showing A) survey scan, B) Ag 3d, C) C 1s, and D) O 1s high-resolution spectra.



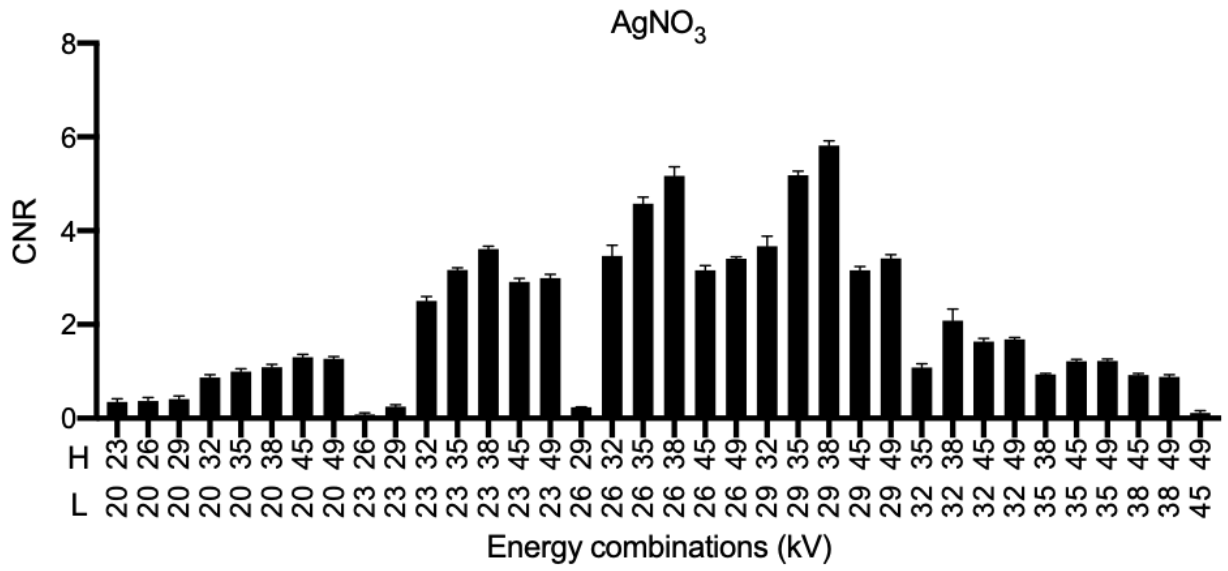
Supplemental Figure 14: ROS generation of J774A.1 cells (macrophages) when incubated with Ag_2Te, Ag_2S, and Ag nanoparticles.



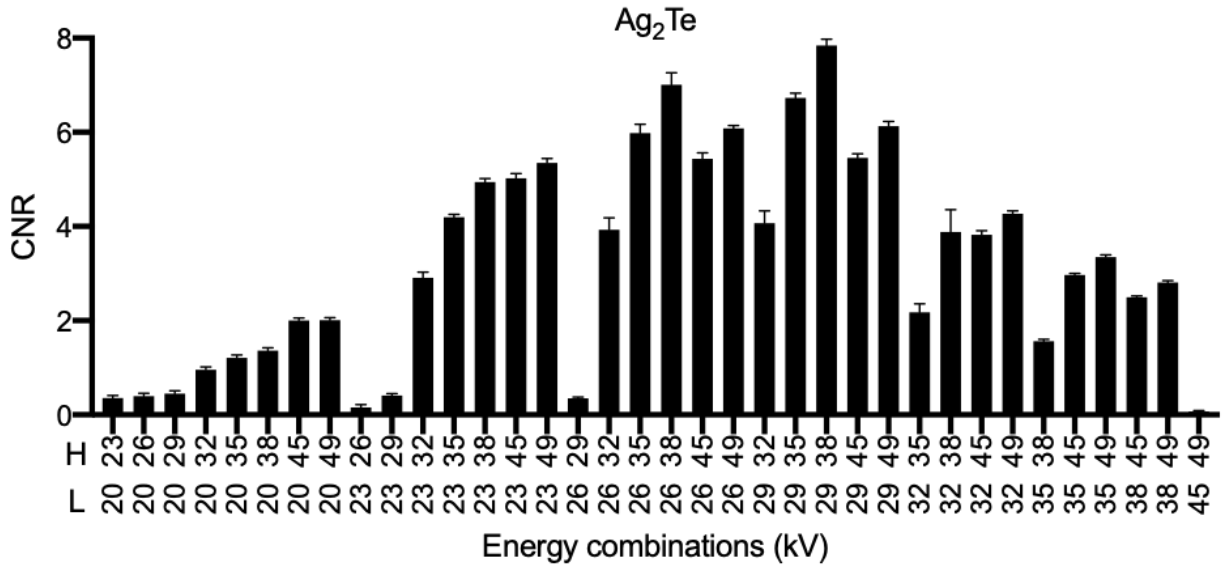
Supplemental Figure 15: DNA damage of HepG2 cells when incubated with Ag_2Te, Ag_2S and Ag nanoparticles at a concentration of 0.25 mg Ag/mL for 4 hrs.



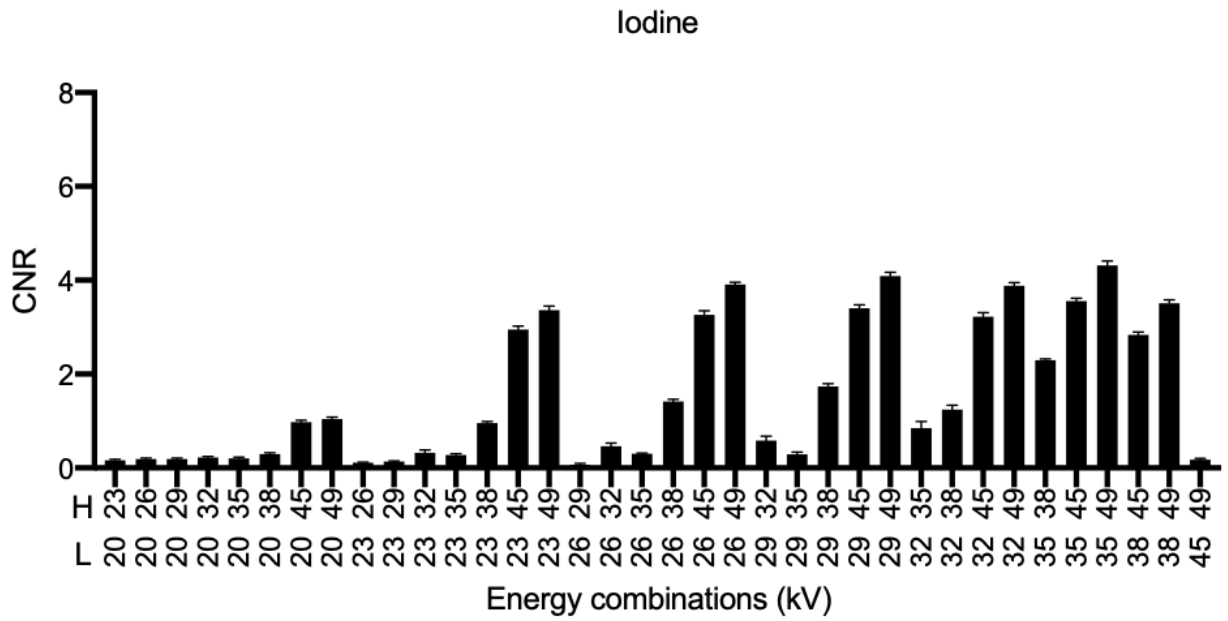
Supplemental Figure 16: Contrast-to-noise ratio (CNR) quantification of DEM phantom images at low energy and high energy combinations of A) LE=26 kV and HE=45 kV (optimal energy pair for Ag) and B) LE=32 kV and HE=49 kV (optimal energy pair for iodine).



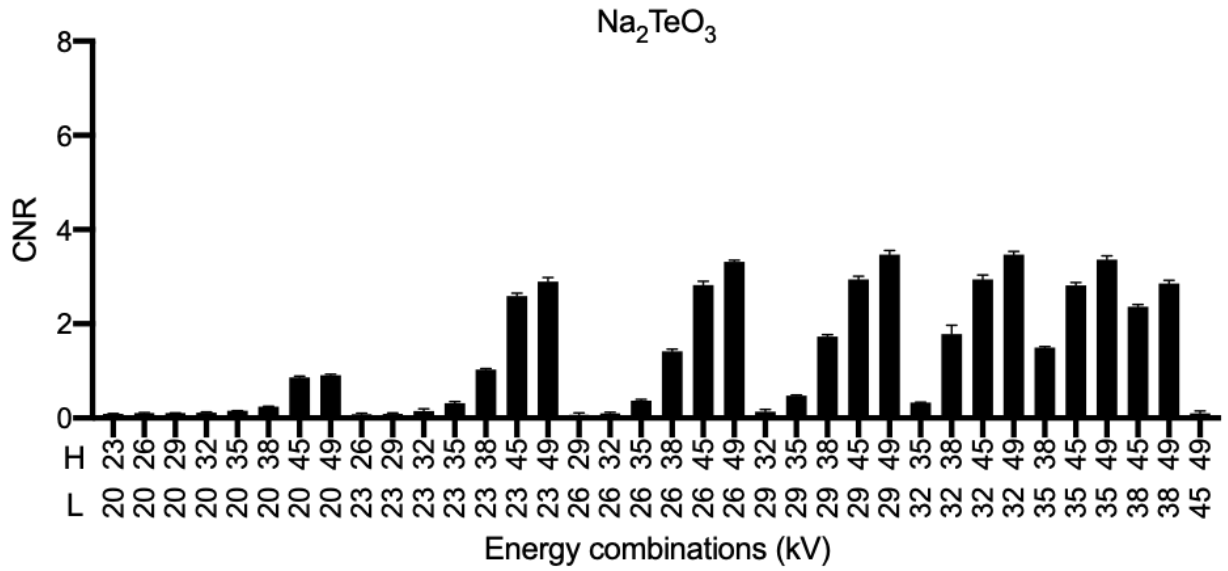
Supplemental Figure 17: Contrast-to-noise ratio (CNR) quantification of DEM phantom images at different energy combinations for $AgNO_3$ solutions at a concentration of 10 mg of Ag/mL. H denotes high energy and L denotes low energy.



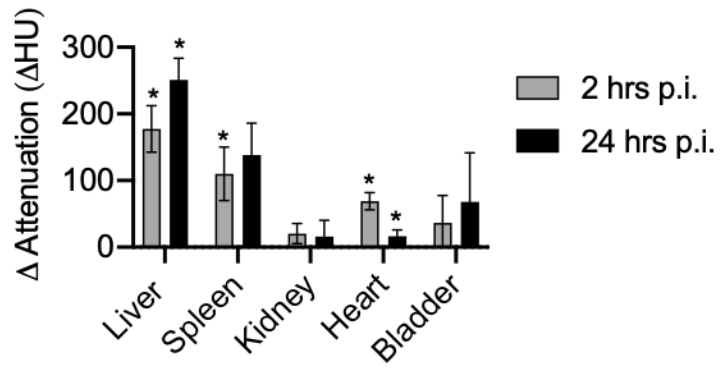
Supplemental Figure 18: Contrast-to-noise (CNR) ratio quantification of DEM phantom images at different energy combinations for Ag_2Te solutions at a concentration of 10 mg of Ag/mL. H denotes high energy and L denotes low energy.



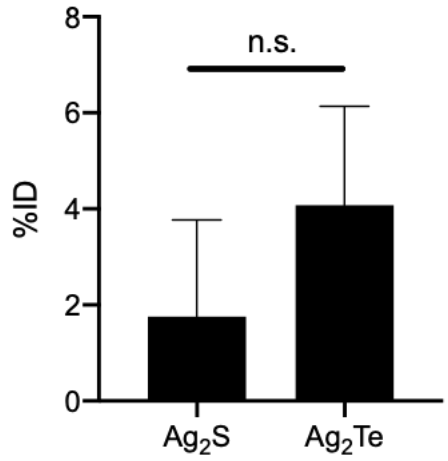
Supplemental Figure 19: Contrast-to-noise (CNR) ratio quantification of DEM phantom images at different energy combinations for Iopamidol solutions at a concentration of 10 mg of iodine/mL. H denotes high energy and L denotes low energy.



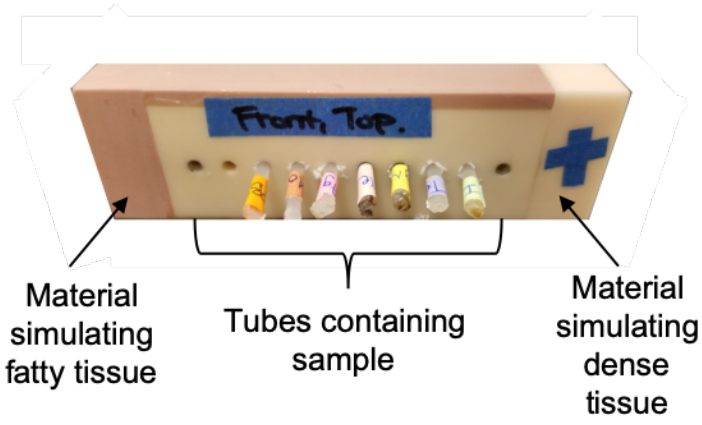
Supplemental Figure 20: Contrast-to-noise (CNR) ratio quantification of DEM phantom images at different energy combinations for Na_2TeO_3 solutions at a concentration of 10 mg of Te/mL. H denotes high energy and L denotes low energy.



Supplemental Figure 21: Quantification of the *in vivo* change in CT attenuation in organs of mice injected with Ag_2S NPs. Statistical comparison versus pre-injection scan. * $P \leq 0.05$, n=6.



Supplemental Figure 22: Quantification of the NP accumulation in tumors of mice injected with Ag_2S and Ag_2Te NPs. Data is presented as percent of injected dose (%ID).



Supplemental Figure 23: Photograph of phantom used for *in vitro* DEM studies.

References:

1. J. C. Hsu, E. D. Cruz, K. C. Lau, M. Bouché, J. Kim, A. D. Maidment and D. P. Cormode, *Chemistry of Materials*, 2019, **31**, 7845-7854.
2. P. C. Naha, K. C. Lau, J. C. Hsu, M. Hajfathalian, S. Mian, P. Chhour, L. Uppuluri, E. S. McDonald, A. D. Maidment and D. P. Cormode, *Nanoscale*, 2016, **8**, 13740-13754.