Supporting Information:

**Figure S1.** TEM images of Fe$_3$O$_4$ NCs synthesized at the same time under different reaction conditions. The ratios shown in the under each image was Fe(acac)$_3$ : OA : OAm : dodecanol.

**Figure S2.** Photographs of Fe$_3$O$_4$ NCs solution (A) and in response to external magnetic field (B); Photographs of Fe$_3$O$_4$ NCs in chloroform (C) and water (D). The bottom scheme shows the formation of water-soluble Fe$_3$O$_4$ NCs by amphiphilic oligomer.
Figure S3. TEM images of Ag NCs synthesized by using Ag(acac) at 110 °C (A, C) and 200 °C (B, D) with different reaction times. (30 min for A and B; 5 h for C and D)

Figure S4. X-ray diffraction patterns of 9 nm Ag NCs. The inset shows photographs of Ag NCs before and after phase transfer and the scheme of the formation of water-soluble Ag NCs by amphiphilic oligomer.
Figure S5. High-resolution TEM images of 16 nm Fe₃O₄- 8 nm Ag (A), 12 nm Fe₃O₄- 6 nm Ag (B), and 5 nm Fe₃O₄- 4 nm Ag (C) heterodimer NCs.

Figure S6. Photographs of Fe₃O₄-Ag NCs solution (A) and in response to external magnetic field (B); C and D are photographs of Fe₃O₄-Ag NCs in chloroform (C) and water (D), respectively. The bottom scheme shows the formation of water-soluble Fe₃O₄-Ag NCs by amphiphilic oligomer.