Figure S1. Dynamic light scattering (DLS) of the AUGNRs (A) and zeta potentials of GNRs, cysteamine-coated GNRs, and AUGNRs (B).

Figure S2: Fluorescence intensity of AUGNRs mixed with 10 mM of glutathione (GSH), 2 μM of GSH, cysteine (Cys), homocysteine (Hcy), glucose (Glu), alanine (Ala), Glutamine (Gly), histidine (His) and glutamic acid (Gln), respectively.
Figure S3. Heating/Cooling experiment of 200 μg/mL ultrasmall GNRs (A) and large size GNRs (C) aqueous solution with exposure of 1.5 W/cm² 808 nm laser irradiation. The continuous wave (CW) laser was switched off after 10 min and the cooling rate was recorded. (B), (D): Plot of time versus negative natural logarithm of the temperature increment for the cooling cycle (after 10 min in A. C). The linear fit of the data points results in a half-life time τ, are 138.26 s and 237.26s respectively.

The photothermal efficiency η can be calculated by eq. (1) as reported by Roper et al.: [1]

\[
\eta = \frac{hS \left( T_{\text{max}} - T_{\text{sur}} \right) - Q_{\text{diss}}}{I \left( 1 - 10^{-A_{\infty}} \right)}
\]  

(1)

Where

\[
hS = \frac{\sum_{i} m_{i} c_{p i}}{\tau_{s}}
\]  

(2)
With

$$\tau_s = -\ln \theta$$  \hspace{1cm} (3)

And

$$\theta = \frac{T(t) - T_{\text{sur}}}{T_{\text{max}} - T_{\text{sur}}}$$ \hspace{1cm} (4)

The half-life time $\tau_s$ is the slope of the linear fit of the experimental data plotted in Figure S2B ($t$ vs. $-\ln \theta$). With values of $m = 0.3$ g and $C_p = 4.2$ J/g·K in eq. (2) and with $\tau_s = 138.26$ s, $T_{\text{max}} = 51.43$ °C, $hS$ (eq. (2)) is equal to 0.3144 W/K. $Q_{\text{diss}}$ was individually calculated to be 0.0126 W.

With the previously measured extinction coefficient at 808 nm, the $A_{808} = 0.8$. With an incident laser power of $I = 1.5$ W cm$^{-2}$, the photothermal efficiency was calculated with eq. (1) to be 24%.

In the same method, the photothermal efficiency of large size GNRs was 17%.

**Figure S4.** UV-vis-NIR absorbance spectra of AUGNRs with or without irradiation.
Figure S5. Relative cell viability of CTAB-coated ultrasmall GNRs. Error bars show standard deviations (n=5).

Figure S6: Fluorescence images analyses of 293T cells incubated with the AUGNRs for 1 h. All scale bars are 10 mm.

Figure S7: Biodistribution of AUGNRs in Balb/c mice bearing or not bearing tumors at day 1 (A) and...
day 7 (B) postinjection measured by inductively coupled plasma atomic emission spectrometric (ICP-AES) analysis of Au in different organs and tissues (n=3). (C) the blood half-life of AUGNRs in Balb/c mice not bearing tumors.