Supplementary Information

Highly photostable and biocompatible graphene oxides with amino acid functionality

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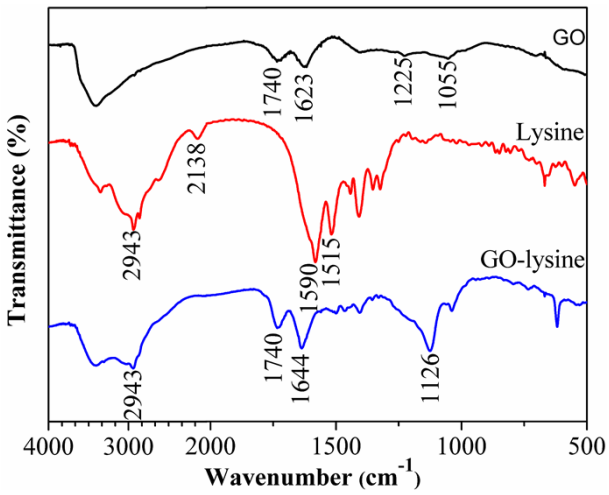

Fig. S1 FTIR spectra of GO, lysine, photoluminescent GO-lysine.

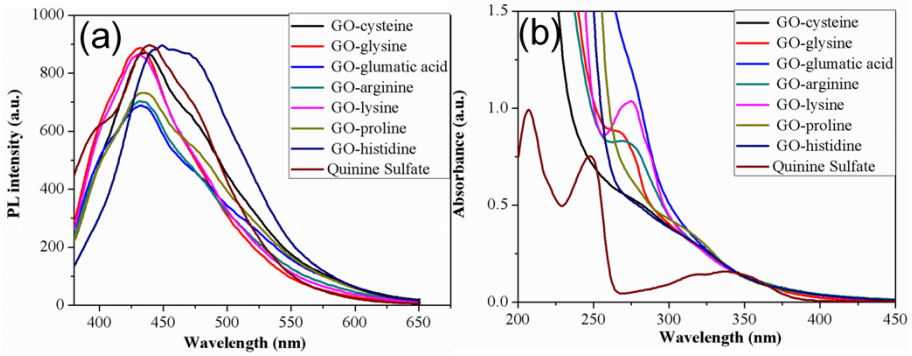

Fig. S2 (a) Photoluminescence spectra of 10^{-6} M quinine sulfate in 0.1 M H_2SO_4 and GO-AAs in ethanol. The concentrations were respectively 30 μg mL^{-1}, 30 μg mL^{-1}, 35 μg mL^{-1}, 45 μg mL^{-1}, 80 μg mL^{-1}, 70 μg mL^{-1}, 90 μg mL^{-1}. (b) UV-vis absorption of 10^{-5} M quinine sulfate in 0.1 M H_2SO_4 and GO-AAs in ethanol (90 μg mL^{-1} of GO-histidine, 120 μg mL^{-1} of GO-glycine, 105 μg mL^{-1} of GO-lysine, 135 μg mL^{-1} of GO-arginine, 80 μg mL^{-1} of GO-cysteine, 70 μg mL^{-1} of GO-proline, 90 μg mL^{-1} of GO-glutamic acid).

Table S1. The photoluminescent quantum yield calculation of GO modified by amino acids in ethanol based on the standard.

Sample	A	F_{350}	η	Φ (%)
quinine sulfate	98352	0.0319	1.333	54
GO-histidine	105982	0.09566	1.366	21
GO-glycine	87049	0.07583	1.366	21
GO-lysine	87951	0.09496	1.366	17
GO-arginine	78125	0.1005	1.366	14
GO-cysteine	98159	0.2621	1.366	6.9
GO-proline	86716	0.127	1.366	6.3
GO-glutamic acid	83108	0.2655	1.366	5.6

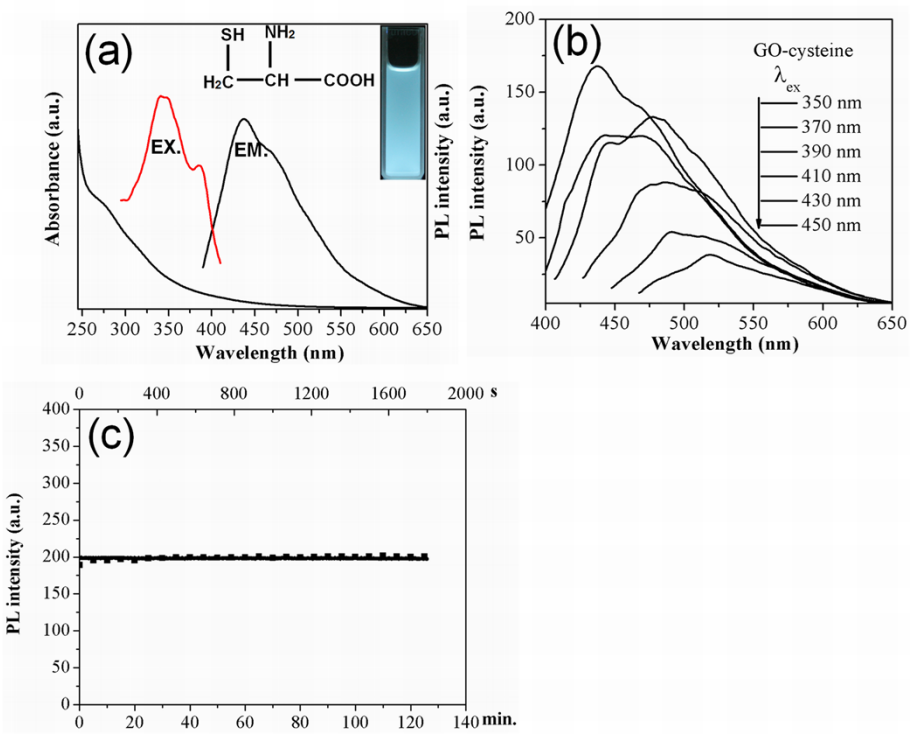

Fig. S3 (a) UV-vis absorption and photoluminescence emission spectra of GO-cysteine in ethanol. The emission spectrum is obtained under excitation at 350 nm, the photograph was taken under 350 nm irradiation, and the excitation spectrum is obtained at the maximum emission wavelength of 440 nm. (b) Photoluminescence emission spectra of GO-cysteine in ethanol are monitored for progressively longer excitation wavelengths from 350 to 450 nm in 20 nm increments. (c) The photostability of GO-cysteine in ethanol. The line represents: the photoluminescence intensity of GO-cysteine (20 μg mL^{-1}) versus the consecutive illumination time under UV light within 30 minutes. The dots represent: the photoluminescence intensity of GO-cysteine (20 μg mL^{-1}) versus the pulse illumination of UV light at 365 nm. Each pulse duration is 30 seconds and the interval between two continuous pulses is 5 minutes.

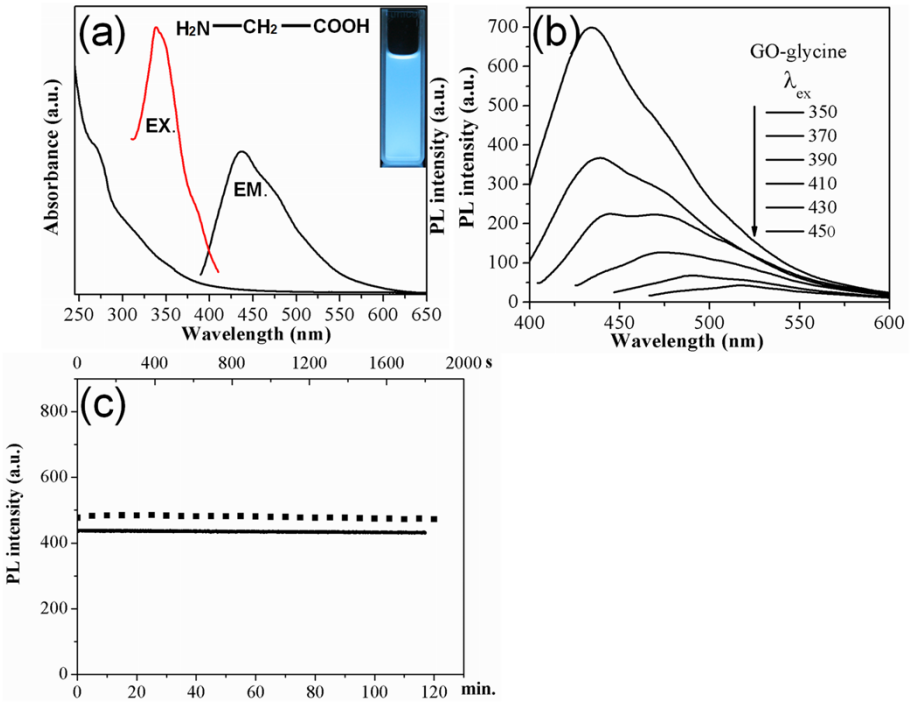

Fig. S4 (a) UV-vis absorption and photoluminescence spectra of GO-glycine in ethanol. The emission spectrum is obtained under excitation wavelength at 350 nm, the photograph was taken under 350 nm irradiation, and the excitation spectrum is obtained at the maximum emission wavelength of 435 nm. (b) Photoluminescence spectra of GO-glycine in ethanol are monitored for progressively longer excitation wavelengths from 350 to 450 nm in 20 nm increments. (c) The photostability of GO-glycine in ethanol. The line represents: the photoluminescence intensity of GO-glycine (15 μg mL^{-1}) versus the consecutive illumination time under UV light within 30 minutes. The dots represent: the photoluminescence intensity of GO-glycine (15 μg mL^{-1}) versus the pulse illumination of UV light at 365 nm. Each pulse duration is 30 seconds and the interval between two continuous pulses is 5 minutes.

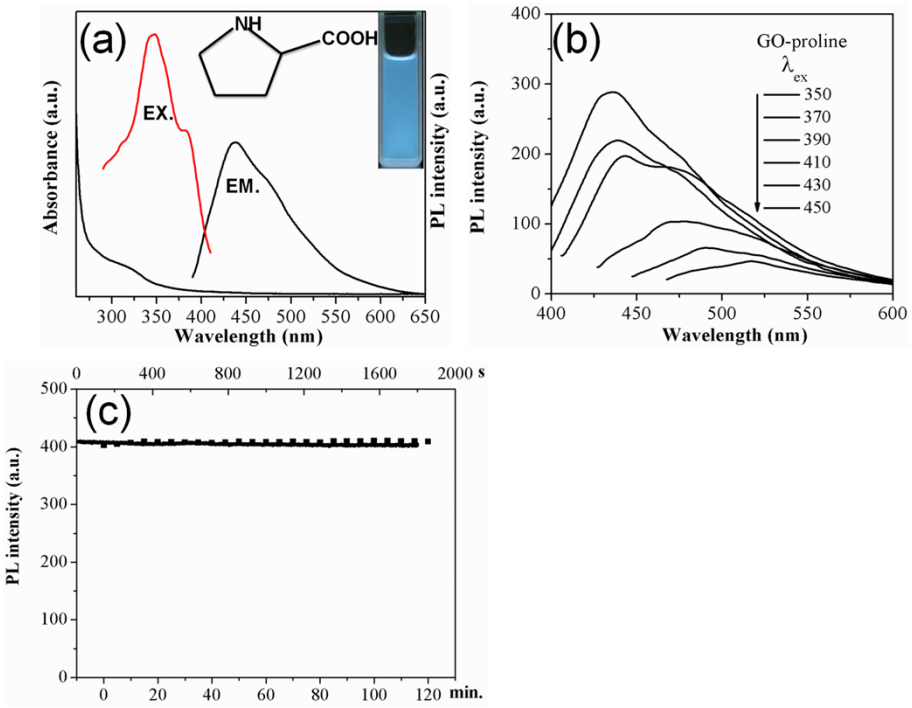

Fig. S5 (a) UV-vis absorption and photoluminescence spectra of GO-proline in ethanol. The emission spectrum is obtained under excitation wavelength at 350 nm, the photograph is taken under 350 nm irradiation, and the excitation spectrum is obtained at the maximum emission wavelength of 435 nm. (b) Photoluminescence spectra of GO-proline in ethanol are recorded for progressively longer excitation wavelengths from 350 to 450 nm in 20 nm increments. (c) The photostability of GO-proline in ethanol. The line represents: the photoluminescence intensity of GO- proline (65 μg mL^{-1}) versus the consecutive illumination time under UV light within 30 minutes. The dots represent: the photoluminescence intensity of GO-proline (65 μg mL^{-1}) versus the pulse illumination of UV light at 365 nm. Each pulse duration is 30 seconds and the interval between two continuous pulses is 5 minutes.

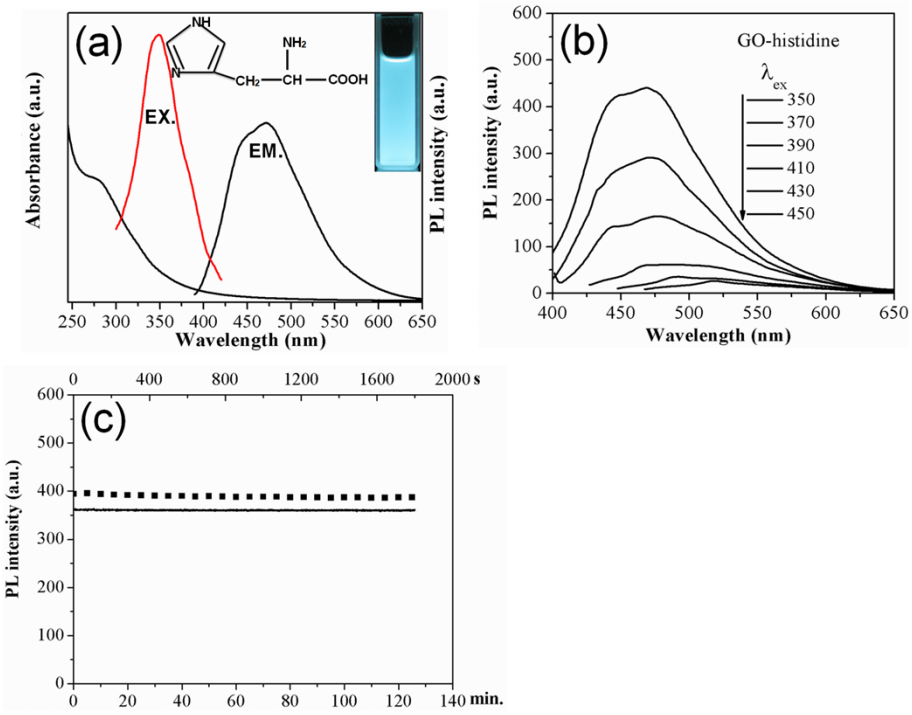

Fig. S6 (a) UV-vis absorption and photoluminescence spectra of GO-histidine in ethanol. The emission spectrum is obtained under excitation wavelength at 350 nm, the photograph is taken under 350 nm irradiation, and the excitation spectrum is obtained at the maximum emission wavelength of 470 nm. (b) Photoluminescence spectra of GO-histidine in ethanol are monitored for progressively longer excitation wavelengths from 350 to 450 nm in 20 nm increments. (c) The photostability of GO-histidine in ethanol. The line represents: the photoluminescence intensity of GO-histidine (10 μg mL^{-1}) versus the consecutive illumination time under UV light within 30 minutes. The dots represent: the photoluminescence intensity of GO-histidine (10 μg mL^{-1}) versus the pulse illumination of UV light at 365 nm. Each pulse duration is 30 seconds and the interval between two continuous pulses is 5 minutes.

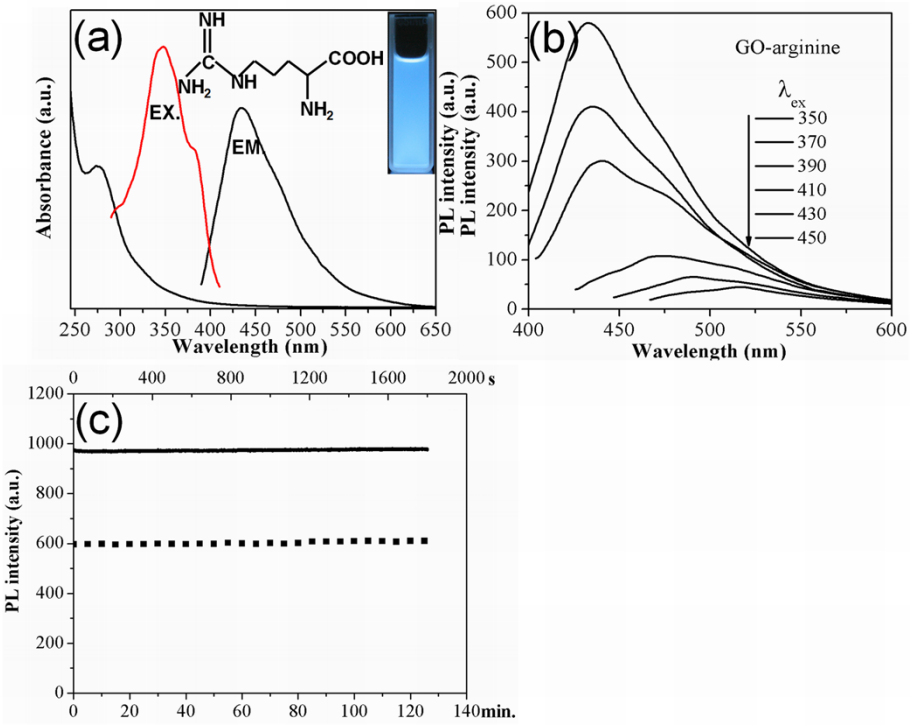

Fig. S7 (a) UV-vis absorption and photoluminescence spectra of GO-arginine in ethanol. The emission spectrum is obtained under excitation wavelength at 350 nm, the photograph is taken under 350 nm irradiation, and the excitation spectrum is obtained at the maximum emission wavelength of 430 nm. (b) Photoluminescence spectra of GO-arginine in ethanol are monitored for progressively longer excitation wavelengths from 350 to 450 nm in 20 nm increments. (c) The photostability of GO-arginine in ethanol. The line represents: the photoluminescence intensity of GO-arginine (50 μg mL^{-1}) versus the consecutive illumination time under UV light within 30 minutes. The dots represent: the photoluminescence intensity of GO-arginine (30 μg mL^{-1}) versus the pulse illumination of UV light at 365 nm. Each pulse duration is 30 seconds and the interval between two continuous pulses is 5 minutes.

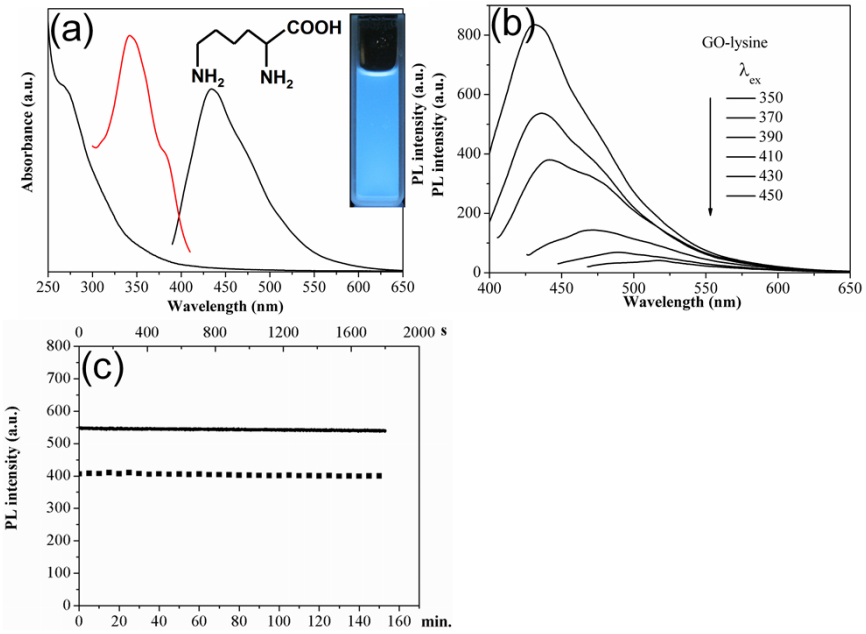

Fig. S8 (a) UV-vis absorption and photoluminescence spectra of GO-lysine in water. The emission spectrum is obtained under excitation wavelength at 350 nm, the photograph is taken under 350 nm irradiation, and the excitation spectrum is obtained at the maximum emission wavelength of 430 nm. (b) Photoluminescence spectra of GO-lysine in water are monitored for progressively longer excitation wavelengths from 350 to 450 nm in 20 nm increments. (c) The photostability of GO-lysine in water. The line represents: the photoluminescence intensity of GO-lysine (25 μg mL^{-1}) versus the consecutive illumination time under UV light within 30 minutes. The dots represent: the photoluminescence intensity of GO-lysine (15 μg mL^{-1}) versus the pulse illumination of UV light at 365 nm. Each pulse duration is 30 seconds and the interval between two continuous pulses is 5 minutes.

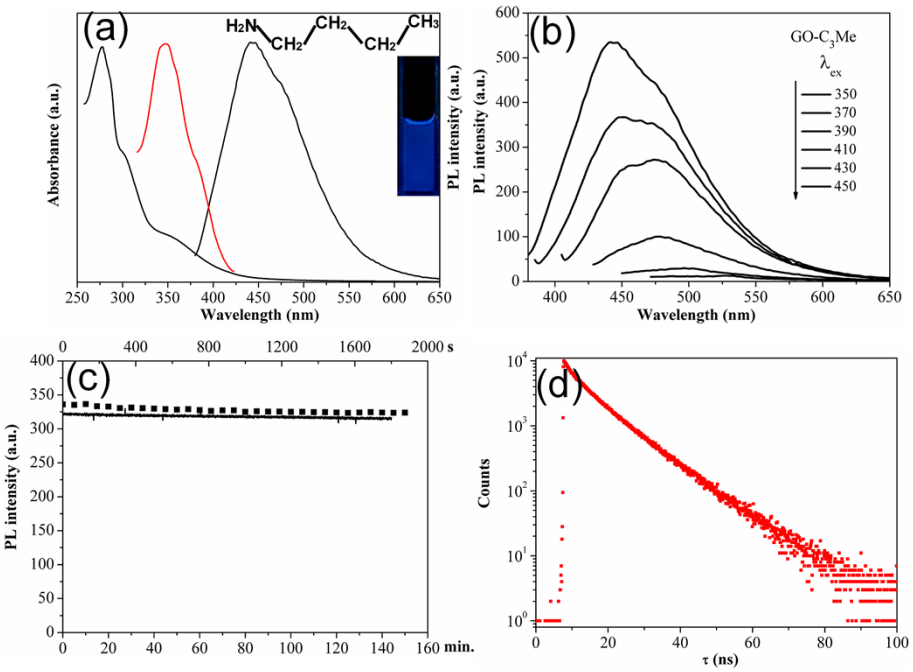

Fig. S9 (a) UV-vis absorption and photoluminescence spectra of GO-C_3Me in water. The emission spectrum is obtained under excitation wavelength at 350 nm, the photograph is taken under 350 nm irradiation, and the excitation spectrum is obtained at the maximum emission wavelength of 440 nm. (b) Photoluminescence spectra of GO-C_3Me in water are monitored for progressively longer excitation wavelengths from 350 to 450 nm in 20 nm increments. (c) The photostability of GO-C_3Me in water. The line represents: the photoluminescence intensity of GO-C_3Me (6.03 μg mL^{-1}) versus the consecutive illumination time under UV light within 30 minutes. The dots represent: the photoluminescence intensity of GO-C3Me (6.03 μg mL^{-1}) versus the pulse illumination of UV light at 365 nm. Each pulse duration is 30 seconds and the interval between two continuous pulses is 5 minutes. (d) Fluorescence decay traces of GO-C_3Me, PL decay curve was measured at an emission wavelength of 375nm. The fluorescence lifetime was measured to be 9.04 ns.

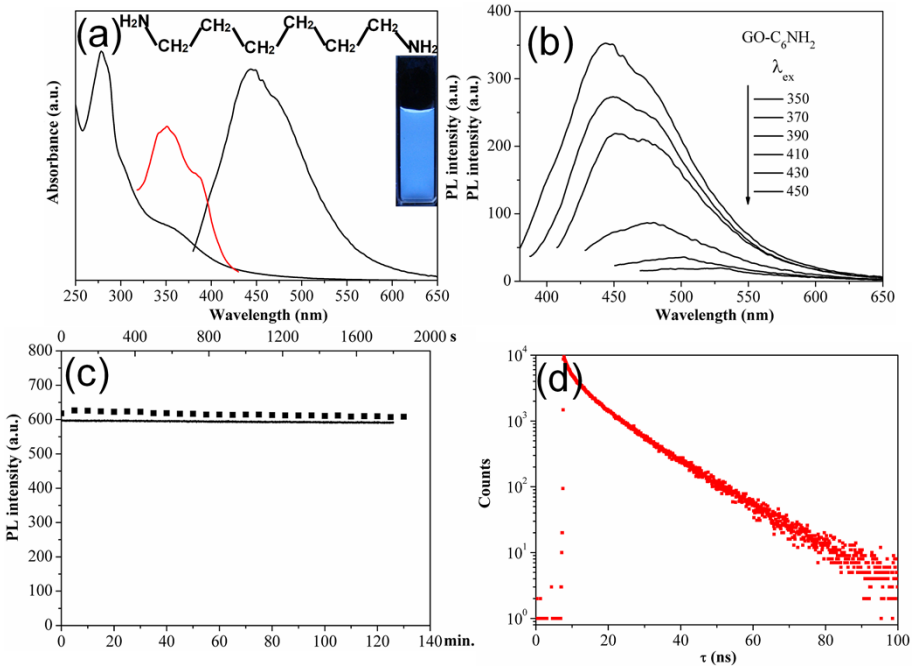

Fig. S10 (a) UV-vis absorption and photoluminescence spectra of GO-C_6NH_2 in water. The emission spectrum is obtained under excitation wavelength at 350 nm, the photograph is taken under 350 nm irradiation, and the excitation spectrum is obtained at the maximum emission wavelength of 440 nm. (b) Photoluminescence spectra of GO-C_6NH_2 in water are monitored for progressively longer excitation wavelengths from 350 to 450 nm in 20 nm increments. (c) The photostability of GO-C_6NH_2 in water. The line represents: the photoluminescence intensity of GO-C_6NH_2 (7.75 μg mL^{-1}) versus the consecutive illumination time under UV light within 30 minutes. The dots represent: the photoluminescence intensity of GO-C_6NH_2 (7.75 μg mL^{-1}) versus the pulse illumination of UV light at 365 nm. Each pulse duration is 30 seconds and the interval between two continuous pulses is 5 minutes. (d) Fluorescence decay traces of GO-C_6NH_2, PL decay curve was measured at an emission wavelength of 375nm. The fluorescence lifetime was measured to be 9.90 ns.

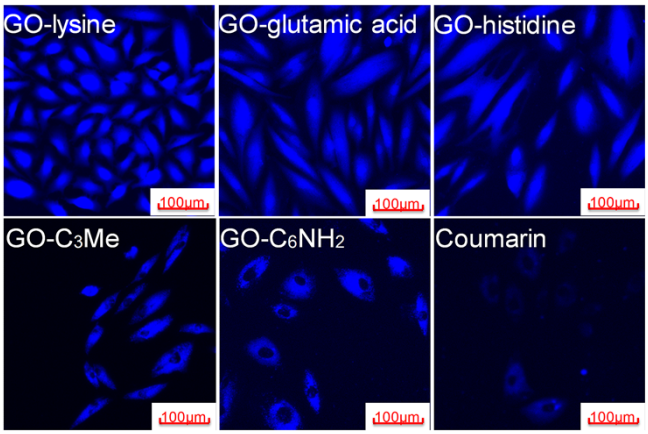

Fig. S11 Fluorescence images of A549 cells for the cellular internalization of GO-lysine, GO-glutamic acid, GO-histidine, GO-C_3Me, GO-C_6NH_2, Coumarin for 24 h, respectively. The A549 cells were first incubated with these probes, and the fluorescence images were obtained after washing with PBS three times. The scale is 100 μm.

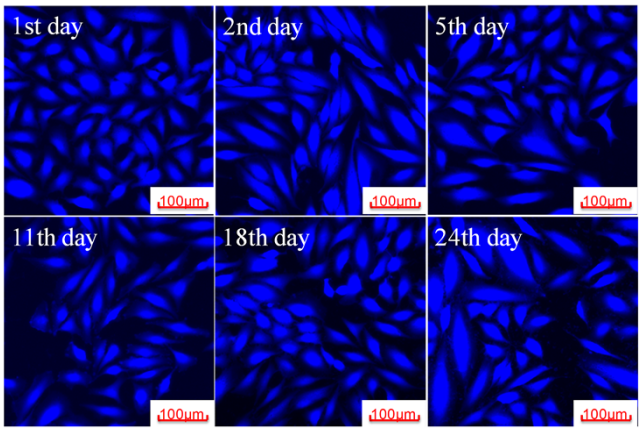

Fig. S12 Cellular internalization and the time response of GO-lysine by intracellular. The A549 cells were first stained with blue photoluminescent GO-lysine after incubation 24 hours. Then, these cells were continued to be respectively incubated for several days, after washing with PBS three times. The scale is 100 μm.

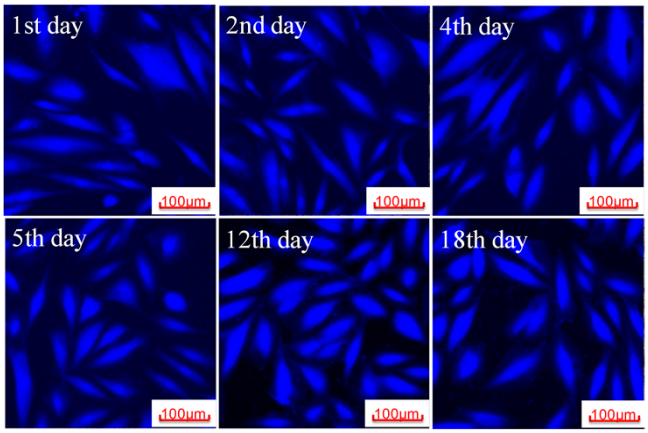

Fig. S13 Cellular internalization and the time response of GO-histidine by intracellular The A549 cells were first stained with blue photoluminescent GO-histidine after incubation 24 hours. Then, these cells were continued to be respectively incubated for several days, after washing with PBS three times. The scale is 100 μm.