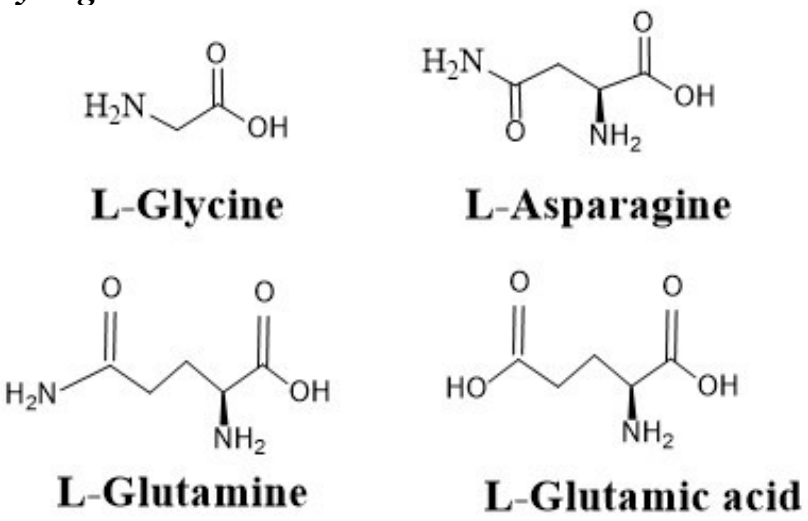
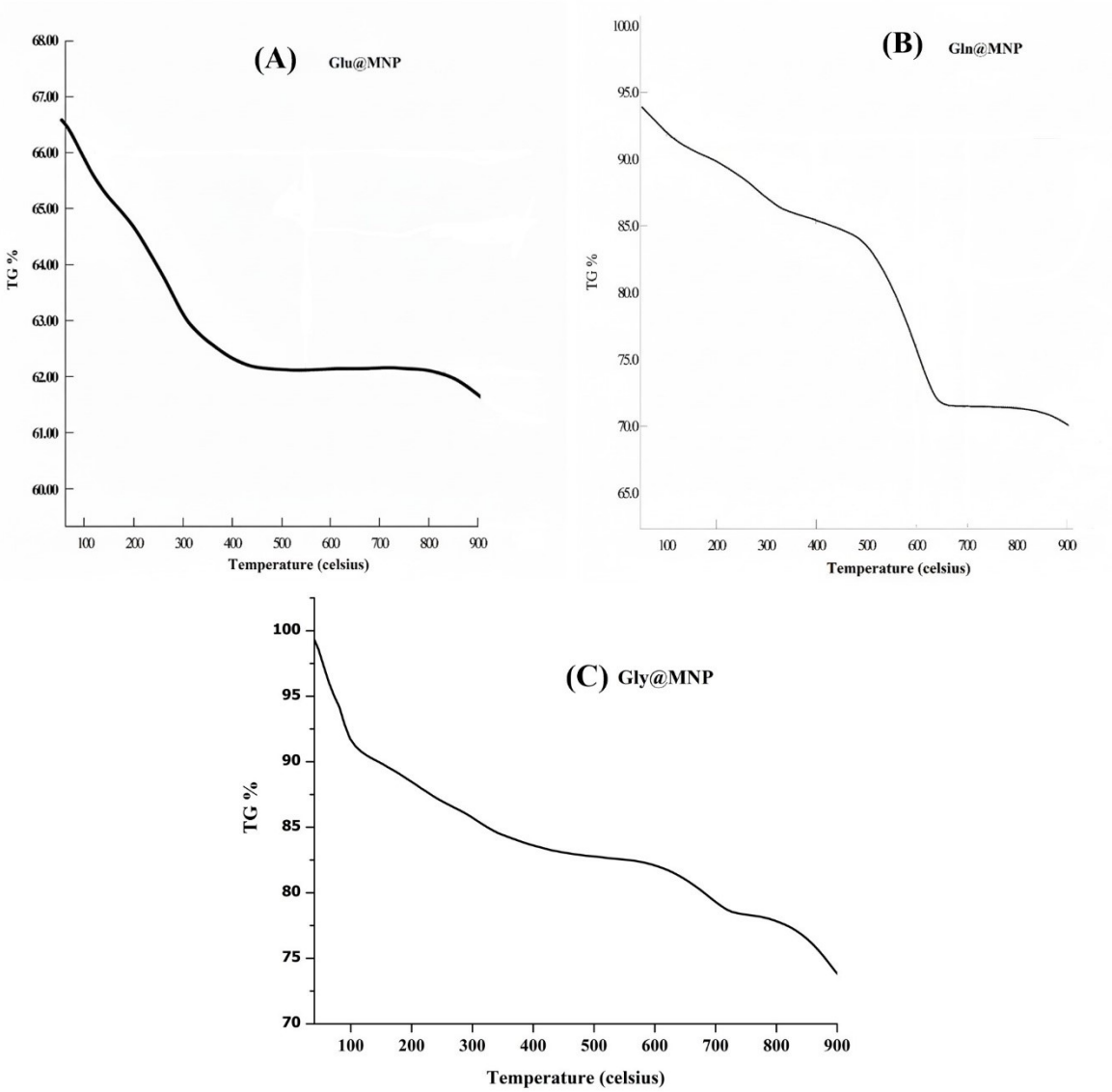
SUPPLEMENTARY DATA

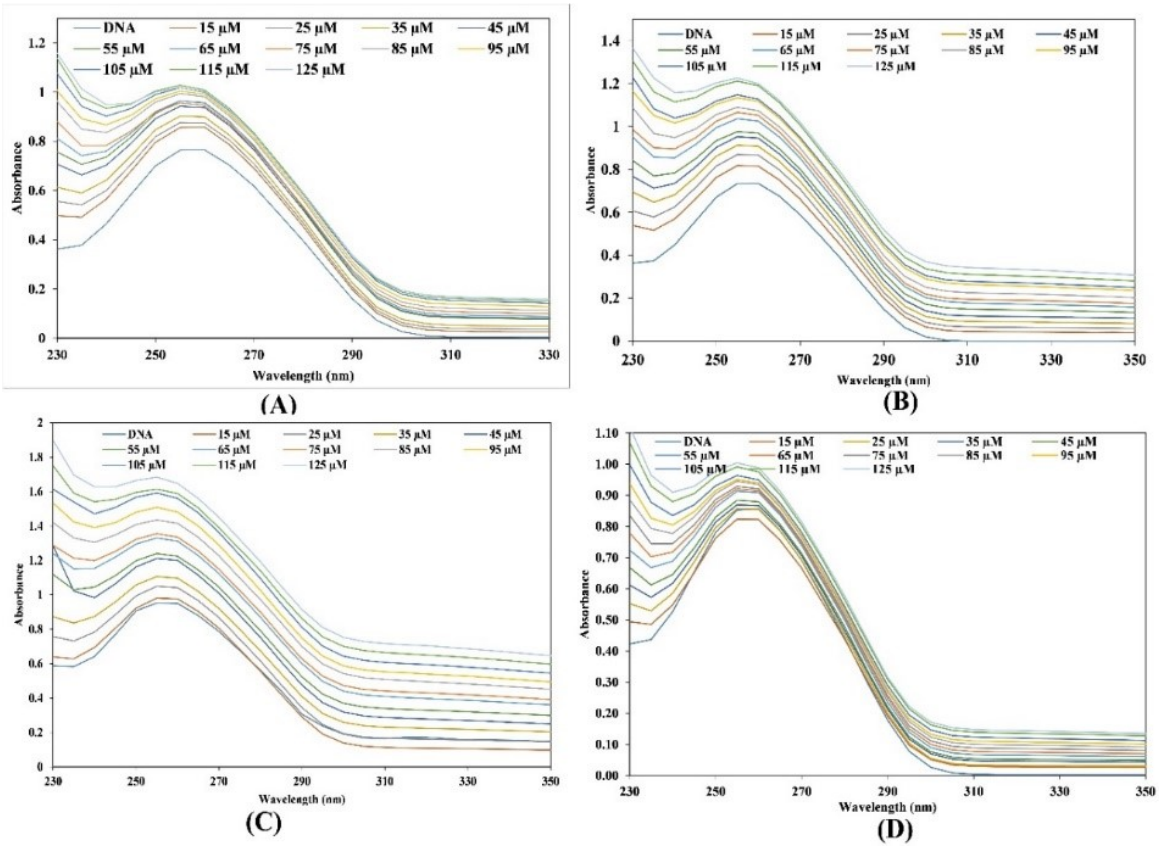
Supplementary Figures



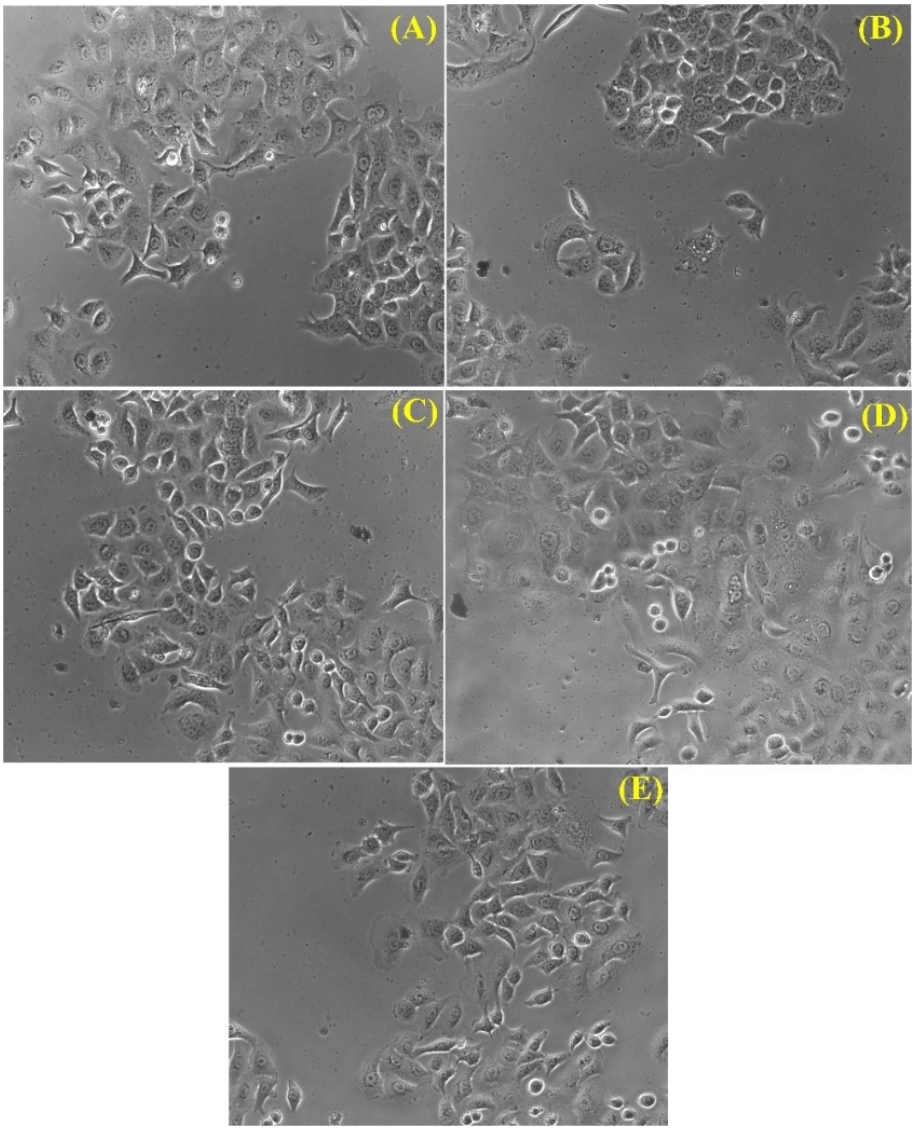
Supplementary Figure 1: Chemical structure of aminoacids used for functionalization of MNP. (Prepared using Chemdraw)



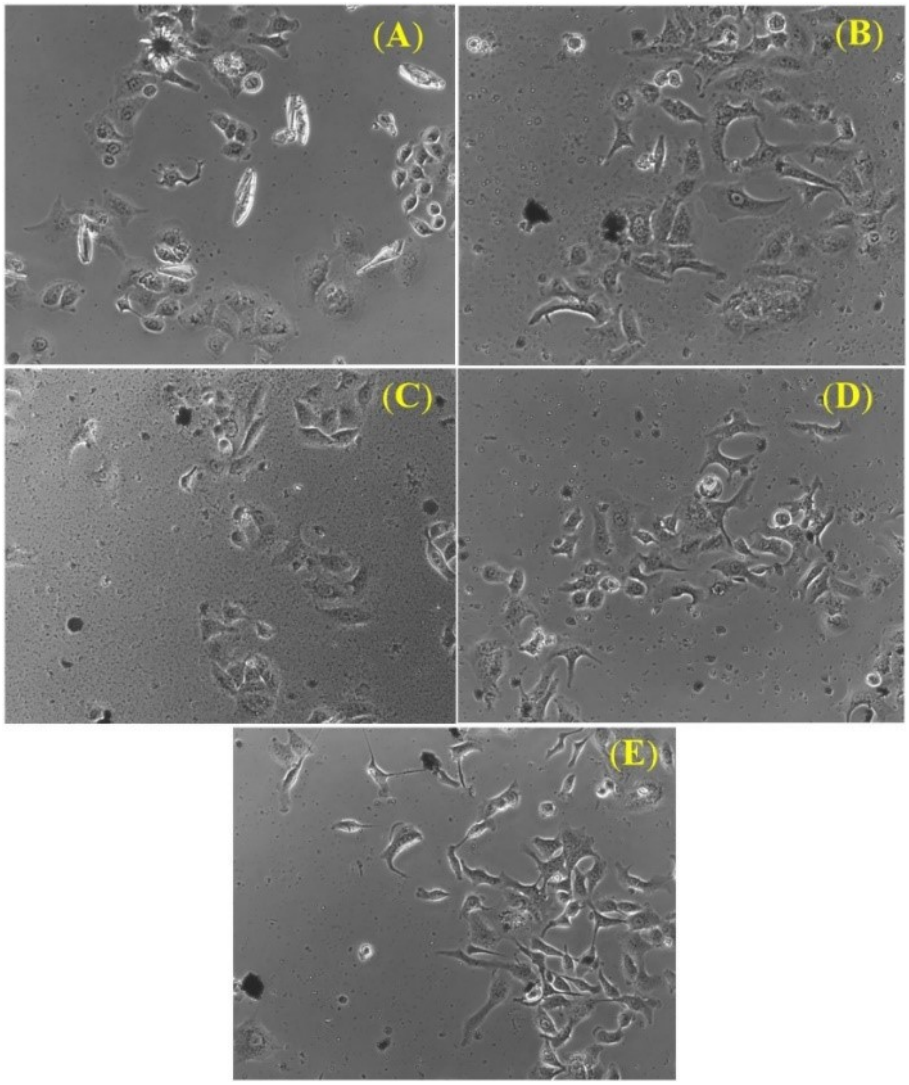
Supplementary Figure *2*: Thermogram showing the % of weight loss of (**A**) Glu@MNP, (**B**) Glu@MNP and (**C**) Gly@MNP



Supplementary Figure 3: Changes of UV spectra of Salmon testes (ST) DNA in the presence of different concentrations of (**A**) Asp@MNPs, (**B**) Glu@MNPs, (**C**) Gln@MNPs, and (**D**) Gly@MNPs in Tris-base buffer (0.1 M), pH 7.5 at 37 °C.



Supplementary Figure 4: Microscopic images of A549 cell line without (**A**) and with treating (**B**) Gln@MNPs, (**C**) Gly@MNPs, (**D**) Glu@MNPs, and (**E**) Asp@MNPs, providing visual evidence of the effects of various nanoparticle treatments on cell morphology



Supplementary Figure 5: Microscopic images of A549 cell line with treating (**A**) SB alone and (**B**) SB loaded Gln@MNPs, (**C**) SB loaded Gly@MNPs, (**D**) SB loaded Glu@MNPs, and (**E**) SB loaded Asp@MNPs, providing visual evidence of the effects of various nanoparticle treatments on cell morphology

Supplementary Tables

Supplementary Table 1: Crystallite parameters determined using XRD.

Nanoparticles	Interplanar Spacing (d_{hkl}) (nm)	Crystalline Size (nm)	Lattice Parameter (a) (nm)	Specific Surface Area (SSA) (m^2/g)	Wt. % Magnetite
MNPs	0.2528	19.56	0.83837	59.56	61.54
Glu@MNPs	0.2532	8.81	0.83970	132.242	28.38
Gly@MNPs	0.2529	11.24	0.83881	103.652	61.65
Asp@MNPs	0.2500	11.79	0.82910	98.817	16.66
Gln@MNPs	0.2502	13.86	0.82982	84.058	45.71

Supplementary Table 2: The mean diameter, zeta potential and polydispersity index of AA@MNP in 40% aq. Glycerol.

Nanoparticles	Mean diameter ($\Sigma_{ø}$) (nm)	Polydispersity index (PDI)	Zeta potential (ζ) (mV)	Electrical Conductivity (C) (µS/sec)	Charge (q) (fC)
MNPs	215.9±4.67	0.01548	-30.69	23	-0.04260
Glu@MNPs	205.7±3.25	0.0192	76.39	30	0.101
Gly@MNPs	185.3±1.23	0.0192	-1.8	46	-0.00209
Asp@MNPs	234.4±4.27	0.0062	1.77	31	0.003
Gln@MNPs	230.9±2.74	0.0195	-79.06	39	-0.113

Supplementary Table 3: % scavenging activity of AA@MNP against DPPH•

Con. (µM)	% of Scavenging activity of AA@MNP				
	STD	Gly@MNPs	Glu@MNPs	Gln@MNPs	Asp@MNPs
25	6.41	40.2	55.7	39.6	45.7
50	24.8	40.3	57.3	39.6	46.1
75	60.8	42.9	57.3	42.5	48.1
100	90.7	45.5	57.6	43.7	48.6
125	92.2	46.1	61.2	44.2	49.2
150	94.2	46.4	61.6	48.1	50.1
SC50 (µg/mL)	31	54.97	91.76	65.22	289.41

Supplementary Table 4: % hyperchromicity and binding constant of AA@MNP with ST-DNA.

Con.	**% hyperchromicity of AA@MNP with ST-DNA.**			
(μM)	*Asp@MNPs*	*Glu@MNPs*	*Gln@MNPs*	*Gly@MNPs*
15	12.08	-14.20	2.81	-4.08
25	14.27	-8.77	9.58	-0.24
35	17.55	-4.37	15.42	1.07
45	22.53	-0.40	26.29	2.53
55	23.42	1.98	28.78	6.01
65	24.84	7.95	38.07	6.59
75	25.08	10.74	40.54	7.35
85	28.22	13.04	48.98	8.99
95	29.39	17.58	55.84	9.61
105	30.73	18.59	64.22	10.71
115	31.76	25.38	67.19	13.74
125	30.32	26.30	73.40	15.23
Binding constant (Kb) of AA@MNP				
$\mathbf{K_b}$ (M^{-1})	2.37×10^3	2.50×10^3	2.45×10^3	1.6×10^3

Supplementary Table 5: The determined ZOI of AA@MNP against various microbes, providing quantitative evidence of its inhibitory action against these pathogenic microorganisms

Antimicrobial agent	**ZOI (mm)**		
	B. subtilis	*E. coli*	*C. albicans*
Gly@MNPs	-	7.04	7.26
Glu@MNPs	-	7.24	-
Asp@MNPs	-	-	-
Gln@MNPs	-	-	-
Chloramphenicol	28.67	28.35	NA
Amphotericin B	NA	NA	9.62

Supplementary Table 6: The determined MIC of AA@MNP against *E. coli* and *C. albicans,* providing critical insights into the antimicrobial potency of AA@MNP

Nanoparticle	Minimum inhibitory concentration (μg/mL)	
	E. coli	*C. albicans*
Gly@MNPs	128	128
Glu@MNPs	64	1024
Asp@MNPs	>1024	>1024
Gln@MNPs	>1024	>1024

Supplementary Table 7: SB release %, cumulative release, standard error, dissolution constant and free energy of released SB from SB-AA@MNPs.

Drug complex	SB release % On 12th hour	Cumulative release % On 12th hour	Standard error %	Dissociation constant (Kd) M	ΔG Kcal/mol
SB-Gly@MNP	18.24	24.53	1.70	5.05×10^{-8}	-3.57
SB-Gln@MNP	47.79	76.12	1.88	1.53×10^{-7}	-4.63
SB-Glu@MNP	43.62	80.70	1.48	6.08×10^{-8}	-4.58
SB-Asp@MNP	38.30	84.99	1.90	4.86×10^{-6}	-4.52

Supplementary Table 8: Mathematical models for drug dissolution kinetics from AA@MNPs.

Drug complex	Zero- order	First- order	Higuchi	Hixson- Crowll
SB-Gly@MNP	0.9957	0.9919	0.9590	0.993
SB-Gln@MNP	0.9845	0.9812	0.9794	0.9845
SB-Glu@MNP	0.9845	09757	0.9788	0.9845
SB-Asp@MNP	0.9823	0.9654	0.9815	0.9823