

LIST OF FIGURES:

Figure No.	Title of Figure	Page No.
1.1	Schematic of structure of nanoparticle platform for targeted drug delivery.	3
2.1	Most commonly diagnosed cancers, 2012. (Compiled from GLOBOCAN 2012.)	15
2.2	The impact of nanoparticle properties on systemic delivery to tumours.	32
2.3	Number of publications per year indexed in the ISI Web of Science on the topic of “mesoporous” and “silica” and “drug” and “delivery” up to 1st November 2017.	41
2.4	Formation of mesoporous materials by structure-directing agents: a) true liquid-crystal template mechanism, b) cooperative liquid crystal template mechanism.	42
2.5	Grafting (postsynthetic functionalization) for organic modification of mesoporous silica with terminal organosilanes of the type (R'O)3SiR. R=organic functional group.	49
2.6	Co-condensation method (direct synthesis) for the organic modification of mesoporous silica. R=organic functional group.	51
3.1	Standard calibration curve of DOX in PBS 7.4 by UV Visible spectroscopy.	101
3.2	UV visible spectra of DOX, MSN and CuO-MSN in PBS 7.4 for interference studies.	102
3.3	Standard calibration curve of DOX in PBS 7.4 by fluorescence spectroscopy.	104
3.4	Standard calibration curve of DOX in phosphate buffer (pH 5.5) by fluorescence spectroscopy.	106
3.5	Standard calibration curve of CuCl ₂ in DDW by Atomic Absorption Spectroscopy.	109

3.6	Standard calibration curve of ZnCl ₂ in DDW by Atomic Absorption Spectroscopy.	110
3.7	Standard calibration curve of APTES in methanol by UV Visible spectroscopy.	112
3.8	Standard calibration curve of Folic acid in 0.1N NaOH by UV Visible spectroscopy.	114
3.9	Standard calibration curve of silicic acid in PBS (pH 7.4) by UV Visible spectroscopy.	117
3.10	Standard calibration curve of silicic acid in urine by UV Visible spectroscopy.	119
4.1	Fluctuation in intensity of light due to difference in particle size.	129
4.2	Particle size and zeta potential of MCM-41 type of MSNs.	139
4.3	Particle size of different SBA-16 type of MSNs.	140
4.4	Zeta potential of different SBA-16 type of MSNs.	140
4.5	Particle size of different MO-MSNs.	141
4.6	Zeta potential of different MO-MSNs.	142
4.7	Anti-angiogenic activity of MO-MSNs studied by performing CAM assay: Control (A), Treatment groups (Batch MO3=B, MO4=C, MO1=D and MO2=E).	143
4.8	Graphical representation of the surface area and pore volume of MSNs (Batch F2) and CuO-MSNs (Batch MO1): Isotherm Linear Plot of MSNs, BET surface area plot and dV/dD Pore Volume of MSNs (A, C & E); Isotherm Linear Plot of MSNs, BET surface area plot and dV/dD Pore Volume of CuO-MSNs (B, D & F).	147
4.9	Morphological characterization of nanoparticles: TEM images with corresponding SAED for MSNs (A) and for CuO-MSNs (B).	148
4.10	Morphological characterization of nanoparticles: FEG-SEM images of MSNs (A), and CuO-MSNs (B).	149
4.11	FEG-SEM-EDS mapping representing elemental composition of MSNs:	150

	Oxygen (A); Silicon (B); Sodium (C); Copper (D) and EDS spectrum (E).	
4.12	FEG-SEM-EDS mapping representing elemental composition of CuO-MSNs: Oxygen (A); Silicon (B); Copper (C); overlay (D) and EDS spectrum (E).	151
4.13	X-Ray diffraction pattern: SAXS of MSNs (A) and WAXS of MSNs (B).	153
4.14	X-Ray diffraction pattern: SAXS of CuO-MSNs (A) and WAXS of MSNs (B).	153
5.1	Hemolytic activity of MSNs against chicken blood cells.	166
5.2	Average body weight of mice treated with single dose of MSNs (Acute toxicity) .	168
5.3	Average body weight of mice treated with single dose of CuO-MSNs (Acute toxicity) .	168
5.4	Average body weight of mice treated with MSNs for 15 days (Sub-acute toxicity).	174
5.5	Average body weight of mice treated with CuO-MSNs for 15 days (Sub-acute toxicity).	175
5.6	Histopathological examination representative of H&E staining of major organs after treatment with MSNs and CuO-MSNs for 15 days (Sub-acute toxicity).	182
5.7	Average body weight of mice treated with MSNs and CuO-MSNs for 60 days (Chronic toxicity).	185
5.8	Histopathological examination representative of H&E staining of major organs after treatment with MSNs and CuO-MSNs for 60 days (Chronic toxicity).	188
5.9	Degradation of MSNs in vitro (PBS 7.4) and in vivo (urine and feces).	191
5.10	Degradation of CuO-MSNs in vitro (PBS 7.4) and in vivo (urine and feces).	192
6.1	Change in the zeta potential of MSNs with change in the amount of APTES added.	209
6.2	FTIR spectrum before and after amino functionalization of MSNs (A) and CuO-MSNs (B).	210

6.3	Change in the zeta potential before and after each functionalization of MSN (A) and CuO-MSN (B).	211
6.4	FTIR spectrum before and after carboxyl functionalization of MSN-NH ₂ (A) and CuO-MSN-NH ₂ (B).	213
6.5	Zeta potential of DOX.	215
6.6	DSC thermogram of DOX (A), DOX-MSN (B) and DOX-CuO-MSN.	216
6.7	FTIR spectrum of CH-FA conjugate.	218
6.8	Change in the particle size of MSN (A) and CuO-MSN (B) after capping with CH-FA conjugate via disulfide bond.	219
6.9	Change in the zeta potential of MSN-COOH (A) and CuO-MSN-COOH (B) after capping with CH-FA conjugate via disulfide bond.	220
6.10	TEM and SAED images of DOX-MSN-SS-CH-FA (A) and DOX-CuO-MSN-SS-CH-FA (B).	221
6.11	FTIR spectrum of: CH-FA conjugate (A), DOX-MSN-SS-CH-FA (B) and DOX-CuO-MSN-SS-CH-FA (C).	222
6.12	In vitro drug release study of: Different DOX-MSN samples in phosphate buffer pH 7.4 (A) and phosphate buffer pH 5.5 (B) and Different DOX-CuO-MSN samples in phosphate buffer pH 7.4 (C) and phosphate buffer pH 5.5 (D) with or without 10mM GSH.	224
6.13	Hemolytic activity of DOX and different DOX loaded formulations.	226
7.1	Cytotoxicity of blank MSNs against MCF-7 cells after 24 h incubation.	237
7.2	Cytotoxicity of CuO-MSNs against MCF-7 cells after 24 h incubation.	237
7.3	Cytotoxicity of ZnO-MSNs against MCF-7 cells after 24 h incubation.	239
7.4	Cytotoxicity of free DOX and DOX loaded nanoparticles measured by MTT assay against MCF-7 cells at 24 hours (A), 48 hours (B) and 72 hours (c).	240

7.5	Cytotoxicity of free DOX and DOX loaded nanoparticles measured by MTT assay against MDA-MB-231 cells at 24 hours (A), 48 hours (B) and 72 hours (c).	241
7.6	Estimation of intracellular ROS by fluorescence microscopy.	243
7.7	The mitochondrial membrane potential ($\Delta\psi_m$) of the cells after treatment with various formulations, measured by flow cytometry.	245
7.8	Estimation of MCF-7 tumor colony inhibition mediated by different formulations: Control (A), DOX (B), DOX-MSN (C), DOX-MSN-SS-CH-FA (D), CuO-MSN (E), DOX-CuO-MSN (F), DOX-CuO-MSN-SS-CH-FA (G).	246
7.9	In vitro scratch assay to determine effect of different formulations: Control (A), DOX (B), DOX-MSN (C), DOX-MSN-SS-CH-FA (D), CuO-MSN (E), DOX-CuO-MSN (F), DOX-CuO-MSN-SS-CH-FA (G) on cell migration.	247
7.10	Evaluation of the apoptosis mechanism of MCF-7 breast cancer cells upon treatment with different formulations. Q1 means early apoptotic cells, Q2 means apoptotic or dead cells, Q3 means non apoptotic viable cells and Q4 means necrotic cells.	249
8.1	Representative image of mice showing weight gain due to EAC and weight loss after Dox treatment (A), Comparison of average body weight change in mice, treated with different MSN formulations (B) and CuO-MSN formulations (C), with control group.	260
8.2	Comparison of average change in tumor volume in mice treated with different MSN formulations (A) and CuO-MSN formulations (B), with control group.	262
8.3	Mean survival time of experimental groups (A), Kaplan-Meier survival curve of mice treated with DOX, MSN formulations and CuO-MSN formulations (B), and %ILS of mice treated with DOX, MSN formulations and CuO-MSN formulations compared to control (C).	264
8.4	Comparison of hematological parameters such as WBCs (A), RBCs (B), HGB (C) and	270

	PLT (D) of different treatment group mice and control group mice.	
8.5	Comparison of hepatic markers AST (A) and ALT (B) in the serum of different experimental groups.	273
8.6	Comparison of renal markers creatinine (A) and BUN (B) in the serum of different experimental groups.	275
8.7	Comparison of CK-MB as a cardiac marker in the serum of different experimental groups.	276
8.8	Comparison of total protein in the serum of different experimental groups.	277
8.9	Histopathological examination of various organs of normal control (A), model control (B), standard control (C), DOX-MSN (D), DOX-MSN-SS-CH-FA (E), CuO-MSN (F), DOX-CuO-MSN (G), and DOX-CuO-MSN-SS-CH-FA (H).	279