

Supplementary Files

Sl No.	Nanoparticle	Effects Observed (in zebrafish)	Toxicity Induced	Reference
1	<ul style="list-style-type: none"> i. Silicon dioxide (SiO₂) ii. Titanium dioxide (TiO₂) iii. Platinum (Pt) 	<ul style="list-style-type: none"> i. Behavioral effects like altered color preferences were found to be caused by SiO₂. ii. Enhanced neuron apoptosis, glial cell proliferation, along with altered gene expression, following exposure to TiO₂. iii. 2 functions- as mitochondrial complex I and antioxidant activity (SOD and catalase mimic activities). 	Neurotoxicity and Behavioral Analysis	(Bai and Tang, 2020; Haque and Ward, 2018)
2	<ul style="list-style-type: none"> i. Gold (Au) ii. Silver (Ag) iii. Platinum (Pt) 	A toxicity study of gold, silver, and platinum nanoparticles during development revealed the accumulation of metals inside the developing embryo, causing a serious threat to the organism. Also, AgNP exposure produced abnormal cardiac morphology, pericardial edema, and circulation defects.	Cardiotoxicity	(Sarmah and Marrs, 2016)
3	<ul style="list-style-type: none"> i. Gold (Au) 	<ul style="list-style-type: none"> i. Gold (Au) NPs have been 		

	ii. Silver (Ag)	<p>shown to disrupt pathways involved in inflammatory and other immune responses.</p> <p>ii. Silver (Ag) NPs caused immunotoxicity in adults due to oxidative stress.</p>	Immunotoxicity	(Haque and Ward, 2018)
4	<p>i. Silver (Ag)</p> <p>ii. Gold (Au)</p> <p>iii. Titanium Dioxide (TiO₂)</p>	<p>i. AgNP exposure gave rise to oxidative stress, caused germ cells apoptosis, and damaged the reproductive ability in fish.</p> <p>ii. AuNPs ranging between 10-50 nm could enter the ovaries of fish and give rise to strand breaks in the ovarian cell.</p> <p>iii. TiO₂ induced autophagy and necrosis at higher doses in Sertoli cells and negatively affected spermatogenic cells.</p>	Reproductive toxicity	(Bai and Tang, 2020)
5	<p>i. Nickel (Ni)</p> <p>ii. Copper (Cu) and Copper oxides (CuO)</p>	<p>i. Nickel NPs accumulate within the lumen of the digestive system.</p> <p>ii. The results revealed that CuO-NPs induced abnormal phenotypes of a smaller head and eyes and delayed epiboly was seen.</p>	Developmental toxicity	(Brundo and Salvaggio, 2018; Dumitrescu et al., 2019)

6	i. Copper (Cu) ii. Zinc (Zn)	Delayed development of pigments and abnormal shape of the eyes.	Ocular toxicity (eyepiece related)	(Hill et al., 2005)
7	i. Silver (Ag) ii. Gold (Au)	AgNPs induce oxidative stress and transcripts of pro-apoptosis genes such as p53 and Bax. Activation of p53 target genes led to cell cycle arrest, prolonged activation of p53 resulted in the induction of apoptosis.	Cytotoxicity	(Bai and Tang, 2020)
8	Titanium Dioxide (TiO ₂)	DNA damage due to exposure to many chemicals, resulting in gene mutations and larger chromosomal alterations.	Genotoxicity	(Haque and Ward, 2018)
9	Silver (Ag)	An increase in cholesterol at high doses of AgNP indicates hepatotoxicity, also molecular Impact, and increment in alkaline phosphatase.	Hepatotoxicity	(Patel et al., 2019)
10	i. Lead (Pb) ii. Uranium (U) iii. Nickel oxide (NiO)	Multiple exposures to heavy metals like lead, cadmium, uranium; cause harmful effects thus acute toxicity. Results showed that chronic exposure of NiONPs leads to an increase in toxicity and accumulation in fish tissue.	Acute toxicity and toxicokinetics	(Bai and Tang, 2020; Hill et al., 2005)

Table S1. Several organ toxicities that are induced in the zebrafish model due to several metal and metal oxide nanoparticles.

Sl No.	Nanoparticle	Toxicity observed	Reference
1	Silver(Ag)	The implantation ratio of treated blastocysts was significantly lower, the weight of the placenta and fetal weight were reduced in the treated group, etc.	(Celá et al., 2014)
2	Gold(Au)	No tail or its flexure, fin fold abnormality, acephaly, cardiac malformation, yolk sac edema.	
3	Copper(Cu)	Malformations delayed hatching on embryos or eggs. Not much effect on adults.	(Haque and Ward, 2018)
4	Zinc(Zn)	Delayed hatching of eggs when they are treated with higher concentrations.	(Chakraborty et al., 2016)
5	Nickel(Ni)	Showed that, the acute toxicity of NiONPs was low but chronic exposure of NiONPs could lead to the accumulation and increase in toxicity in zebrafish tissue.	(Bai and Tang, 2020)
6	Platinum(Pt)	Hatching delay, concentration-dependent drop in heart rate, spinal cord flexure, delayed hatching of eggs also observed.	(Celá et al., 2014)
7	Magnesium(Mg)	Induced cellular apoptosis and intracellular reactive oxygen species. The hatching rate and survival of embryos decreased with higher doses.	(Bai and Tang, 2020)
8	Iron(Fe)	Highest conc. caused oxidative stress in liver cells. Liver microarray analysis revealed almost 1000 DETs between the control and IONP treatment groups.	

Table S2. Metal nanoparticles and their toxic effects in zebrafish.

Sl No.	Metal oxides	Size of the nanoparticle	Concentrations Used	TOXICITY OBSERVED	REFERENCE
1	α -Fe ₂ O ₃	30 nm	≥ 10 mg/L of Iron Oxide	Iron oxide nanoparticles cause mortality, hatching delay, and malformation.	(Bai and Tang, 2020)
2	γ -Fe ₂ O ₃	5.7 nm	Higher Concentrations	Genotoxicity.	
3	ZnO	(i.) and (ii) 47.3 \pm 12.9 up to 1,002.0 \pm 259.2 nm (iii.) and (iv.) 50–360 nm	5 mg/l 10 mg/l 25 mg/l 50 and 100 mg/l	i. Normal body length, lower hatching rate. ii. The shortened body length of larvae, tail malformation, and low hatching rates. iii. The shortened body length of larvae, tail malformation, no hatching iv. No hatching	(Celá et al., 2014)

4	TiO ₂	<ul style="list-style-type: none"> i. 240-280 nm ii. 24.1 ± 2.8 nm iii. 6.5 nm 	<ul style="list-style-type: none"> 0.1 mg/L (13 weeks) 1 mg/L (14 days) 5, 10, 20, 40 µg/L(45 consecutive days) 	<ul style="list-style-type: none"> i. Mortality in adults, organ injury, behavior alteration. ii. Limited oxidative stress and organ pathology but lower no of viable embryos produced. iii. Brain injury, reductions of spatial recognition memory. 	(Bai and Tang, 2020)
5	MgO	20 nm	50, 100, 200, and 400 µg/L	Induces cellular apoptosis and intracellular reactive oxygen species. The hatching rate and survival of embryos decreased in a dose-dependent manner.	
6	CuO	30–50 nm	50, 100, 200, and 400 µg/L	Decreased hatching rate, abnormal notochord formation, no tail, damaged eyes, and abnormal heart development, lack of head development, edema, increase in glutathione, and catalase activity.	(Celá et al., 2014)
7	NiO	30 nm (spherical)	0–1,000 mg/l	Intestinal defects with underdeveloped intestinal epithelial cells (LD10), skeletal muscle defects with the separation of trunk skeletal muscle fibers (LD50), jaw patterning defects (LD50).	
8	Al ₂ O ₃	285–2,450 nm	1,000, 100, 10, 1, 0 mg/l	No toxicity is observed on embryos and larvae even at higher concentrations.	

Table S3. Toxicity induced in zebrafish when they are treated with numerous size and concentrations of metal oxide nanoparticles.

Sl No.	Nanoparticle	Bacterial strain	Plant	Size (in nm)
1	Gold (Au)	<ul style="list-style-type: none"> i. <i>Bacillus subtilis</i> ii. <i>Lactobacillus sp.</i> iii. <i>Escherichia coli</i> iv. <i>Klebsiella pneumoniae</i> 	<i>Andrographis peniculata</i>	<ul style="list-style-type: none"> i. 5-25 ii. 20-50 iii. 20-25 iv. 35-65
2	Silver (Ag)	<ul style="list-style-type: none"> i. <i>Lactobacillus sp.</i> ii. <i>Morganella sp.</i> iii. <i>Bacillus subtilis</i> iv. <i>Bacillus indicus</i> v. <i>B. thuringiensis</i> vi. <i>S. aureus</i> vii. <i>E. coli</i> viii. <i>S. typhimurium</i> 	<i>Calotropis gigantea</i>	<ul style="list-style-type: none"> i. 15-30 ii. 20-21 iii. 5-50 iv. 2.5-13.3
3	Zinc Oxide (ZnO)	<i>Streptomyces sp.</i>	<ul style="list-style-type: none"> i. Aloe vera ii. <i>Azadirachta indica</i> iii. Ginkgo iv. Magnolia 	<ul style="list-style-type: none"> i. 15-20 ii. 50-100 iii. 30-40 iv. 30-40
4	MnO-NP		<i>Syzygium aromaticum</i>	10-20
5	TiO ₂ -NP	<ul style="list-style-type: none"> i. <i>Bacillus subtilis</i> ii. <i>Halomonas elongata</i> <i>IBRC-M 10214</i> 	<ul style="list-style-type: none"> i. <i>Mentha arvensis</i> ii. <i>Azadirachta indica</i> iii. <i>Echinacea purpurea</i> 	~ 120 nm

Table S4. Extraction of some metal and metal oxide nanoparticles from several bacterial strains and plant extracts. [Table adapted from (Verma et al., 2019) and additional pieces of information are taken from (Ahmad et al., 2020; Kumar et al., 2017; Taran et al., 2018; Thakur et al., 2019; Verma et al., 2018a; Vishnu Kirthi et al., 2011)]