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Advances in nanotechnology, nanopollution, nanotoxicology, and nanomedicine

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Nanotechnology is a science that deals with the design, characterization, synthesis, and application of nanoscale materials (1–100 nm). Nanomaterials (NMs) have unique physicochemical characteristics, including ultra-small size, large surface area to mass ratio, and high reactivity. Nanomedicine is the application of nanotechnology in medicine to advance diagnostic, preventive, and therapeutic strategies. The potent antioxidant properties of some NMs open the door to develop new therapies with enhanced, targeted actions. However, oxidative stress is the main adverse effect of metallic oxide NMs, such as nickel oxide, zinc oxide, and titanium dioxide. Therefore, NMs have double-edged effects on cellular redox hemostasis. Recently, many researchers have focused on the ecological and safety issues of synthetic NMs to reduce the risk of their toxicity. The present special issue “Advances in Nanotechnology, Nanopollution, Nanotoxicology and Nanomedicine (ANNNN)” is dedicated to integrate the previous and the current biological, medical, and ecological data on NMs.

- Elkeiy et al. isolated Chitosan NPs from *Artemia salina* and evaluated their anticancer activities in vitro (using

HepG2) and in vivo (diethylnitrosamine-induced hepatocellular carcinoma in rats) (Elkeiy et al. 2018).

- El-Sayed and Kamel and Zahin et al. reviewed the shape and structure of available NPs and their recent applications in medicine to revolutionize medical diagnostics, therapeutics, and prevention in both human and veterinary medicine (El-Sayed and Kamel 2018, 2019; Zahin et al. 2019).
- Elsharkawy et al. evaluated the resistance induced by *Phoma* sp. GS8-3 fungus or nanosilica against cucumber mosaic virus (CMV). They reported that nanosilica is as effective as GS8-3 fungus in upregulating CMV defense-related genes, especially heat shock proteins (Elsharkawy et al. 2018b).
- Another research by Elsharkawy et al. assessed the capability of zinc oxide NPs to protect tomatoes against *Pseudomonas syringae* bacteria. They concluded that zinc oxide NPs enhanced tomato plant growth, exhibited direct anti-bacterial effects, and increased the expression of genes involved in antimicrobial defense (Elsharkawy et al. 2018a).
- Similarly, another study by Hafez et al. has shown that dietary supplementation with zinc oxide NPs improved the immune response (as evidenced by increased serum IgY concentrations, total lymphocytes, and macrophages count) and antioxidant enzymatic activity in broiler chicken (Hafez et al. 2019).
- Barkia et al. examined the acute oral toxicity study of microalgal protein hydrolysates (MPH) from *Bellerochea malleus* on Wistar rats and concluded the overall safety of MPH providing a new evidence for their potential use in nutraceutical applications and functional foods (Barkia et al. 2019).
- Maher et al. reviewed the potential applications of synthetic melanin NPs based on their free radical scavenging activities and suggested that modern

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research techniques can further characterize these NPs to explore their full potential (Maher et al. 2019).

- A different review article by Sayour et al. enumerated the multiple advantages of surface-modified yttrium oxide NPs, including enhanced colloidal stability, free radical scavenging activity, and low risk of cytotoxicity. These advantages could pave the way towards their use as theranostics in neurodegenerative diseases (Sayour et al. 2019).
- Sharma et al. went further to explore the potential benefits of nanoinformatics and biological nanomodeling in designing novel anti-cancer therapies. These technologies can produce nanomedicines with enhanced and targeted effects (Sharma et al. 2019).
- El-Rouby et al. explored another beneficial effect of NPs. They showed that layered double hydroxide beads nanocomposites can act as efficient adsorbents for heavy metals as Cd^{2+} and Cu^{2+} ions from waste water. Furthermore, they assessed the effects of different factors as contact time, adsorbent weight, pH value, and heavy metal ion concentration on the adsorption efficacy (El Rouby et al. 2018).
- Abdeen and Ghoneim aimed to reduce the cost and improve the efficiency of Mg-Co nanoferrites in crude oil adsorption in oily waste water treatment through blending chitosan hydrogel (Abdeen and Ghoneim 2018).
- In terms of nanotoxicity, Fadda et al. aimed to evaluate whether carnosine and melatonin can ameliorate titanium oxide NP-induced oxidative stress, inflammation, DNA damage, and apoptosis in rat liver. They showed promising prophylactic effects for both compounds in hepatoprotection against titanium oxide NP-induced hepatotoxicity (Fadda et al. 2019).
- In the same vein, Kandeil et al. evaluated whether the extract of Moringa seeds can alleviate the oxidative stress induced by titanium oxide NPs in rat brain and improve mitochondrial viability. They showed that Moringa seeds extract can exert these effects through stimulating Nrf2/NQO1 signaling and reducing tissue expression of pro-inflammatory markers, Fas, and caspase-3 (Kandeil et al. 2019).
- Another experiment by Sayed et al. investigated 4-nonylphenol (4-NP)-induced genotoxicity in medaka (*Oryzias latipes*) erythrocytes. They further revealed that medaka were more sensitive to the genotoxic effects of 4-NP than catfish (Sayed et al. 2018).
- Al-Naggar et al. examined the sublethal effects of chronic exposure to CdO and/or PbO nanoparticles on the honey bee (*Apis mellifera* L.) workers. They reported that both CdO and PbO NPs reduced the survival, feeding rate, acetylcholinesterase activity,

and expression of stress-related detoxifying enzymes (Naggar et al. 2018).

- In a review article by Samak et al., the authors summarized the recent literature on the developmental toxicity of carbon, diamond, and graphene NPs during the early stages of chicken embryogenesis (Samak et al. 2018).

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