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Editorial

Cellular Responses to Nanomaterials with Biomedical Applications

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Nanotechnology application to the biomedical field has gained significant interest. Great efforts have been made to develop nanogels, nanoparticles, and nanofibers, among others, to treat cardiovascular diseases, cancer, immune or metabolic system disorder, neurodegeneration, etc. The study of the cellular response against nanomaterials becomes essential for these potential applications. This Special Issue presents original research and review articles that illustrate and stimulate the advances in physiological processes that take place in tissue exposed to nanomaterials, such as cellular stress, adaptation mechanisms, immunological responses, biochemical pathways and cascades, pathologies, and clinical cases, among others.

1. Introduction

Nanomaterials have been gained great importance in the biomedical applications, and the evaluation of the tissue response in presence of them is one of the most important features to assess [1, 2]. Nanomaterials led to an active development of bioactive compounds that promote molecular processes for the regulation of cellular mechanisms. Still, not much literature has reported the mechanism of action of cells that interact with nanomaterials [3].

[4] discussed that physicochemical properties in nanomaterials define biocompatibility, bioactivity, and safety. In this sense, size, chemical composition of the surface, shape, charge, and topography influence cell response [5]. Hence, the proper design of the nanomaterials taking into account the above properties will elicit desired cell responses and enhanced targeting, drug delivery, cell attachment, and differentiation [6].

This special issue has 5 papers that discuss the biological effects of nanomaterials.

[7]. compared the antimicrobial effect of electrospun nanofibers loaded with silver nanoparticles prepared by different methods. It is well known that the antimicrobial bioactivity of silver nanoparticles is effective, and its use is versatile, becoming attractive to the biomedical industry. On the other hand, the electrospun nanofibers possess properties that can widen the applications of silver nanoparticles. However, silver nanoparticle bioactivity depends on the loading of silver ions into electrospun nanofibers. This review compared several methods of incorporating silver particles into electrospun nanofibers and evaluated their antimicrobial activity, discussed each procedure's limitations, and suggested the most promising one. This review showed that the preferred techniques for incorporating silver nanoparticles were direct blending and ultraviolet irradiation methods due to their simplicity and high efficiency. It was also found that polyacrylonitrile nanofibers (PAN) were reported to be the most frequently adopted polymer carrier for silver nanoparticles. In conclusion, silver nanoparticle-loaded nanofibers show high antimicrobial activity, regardless of the employed method [7].

[8] discussed the effects of the arsenic trioxide-loaded PLGA nanoparticles on the proliferation and migration of human vascular smooth muscle cells. In this report, As_2O_3-PLGA-NPs were prepared and characterized. The energy dispersive spectrometry (EDS) has been used to confirm that the prepared nanoparticles contained elements of arsenic. The surface coating of the eluting stent of As_2O_3-PLGA-NPs has the same characteristics as their self-prepared As_2O_3-PLGA-NPs, and it also has a drug-sustained release character. Compared with the control group, cell proliferation and migration cells were significantly suppressed depending on the tested concentration. On the other hand, As_2O_3-PLGA-NP depression mRNA, protein expression of Bcl-2 and MMP-9, and increased Bax mRNA and protein expression were altered when the concentration of the As_2O_3-PLGA-NPs changed. In conclusion, the authors discussed that the As_2O_3-PLGA-NPs inhibit human umbilical vein smooth muscle cell's (HUVSMC's) proliferation and migration. It may work via regulating Bax, Bcl-2, and MMP-9 expression *in vitro* [8].

In another study, the functions of magnetic nanomaterial in cancer diagnosis and therapy were discussed. The magnetic nanomaterials were demonstrated as a useful technology for life science and biomedical engineering in this work. These applications are most promising in cancer diagnosis due to their sensitivity and accuracy. Magnetic nanomaterials are also exploited as targeted drug carriers to increase sensitivity and reduce the side effects of chemotherapeutic drugs. Herein, this study discussed the preparation, characterization, and surface modification of various magnetic nanomaterials and their cancer diagnosis and therapy applications [9].

Moreover, the evaluation of inflammatory and calcification after implanting bioabsorbable poly-L-lactic acid/amorphous calcium phosphate scaffolds in porcine coronary arteries was reported. [10] confirmed that the addition of nanoamorphous calcium phosphate (ACP) materials could improve the support of poly-L-lactic acid (PLLA) vascular scaffolds. Based on this, this group continued to explore the effect of a novel bioresorbable scaffold composed of PLLA and ACP nanoparticles on the inflammation and calcification of surrounding tissues after scaffold implantation in a porcine coronary artery. It was found that there is no statistically significant difference between the evaluated CRP, calcium, and ALP groups at 1, 6, 12, and 24 months. The inflammation score, NF-κB positive expression index, and calcification score in the PLLA/ACP group were lower than those in the PLLA group for 12 and 24 months. The ALP positive expression index in the PLLA/ACP group was lower than that in the PLLA group at 6, 12, and 24 months. Western blot results showed that the IL-6 expression level in the PLLA/ACP group was significantly lower than that in the control group at 6, 12, and 24 months.

Moreover, the expression of BMP-2 in the PLLA/ACP was significantly lower than in the control group at 12 and 24 months. In this study, it was demonstrated that the PLLA/ACP composite scaffold has adequate biocompatibility. Nanoscale ACP incorporation can reduce the inflammatory response induced by the PLLA scaffold acid metabolites, procalcification factor expression in the body, and inhibit tissue calcification, making them optimal for the application and development of degradable vascular scaffolds [10].

Finally, [11], evaluate the antitumor and immunogenic properties of silver and sodium dichloroacetate combination against melanoma. Their main focus was to assess the efficacy of silver and sodium dichloroacetate as dual-function agents in melanoma treatment. Moreover, the group evaluated if the cell death mechanism induced by their treatments was immunogenic cell death. Their results showed that colloidal silver and sodium dichloroacetate combination is more effective than each treatment alone and that the antitumor mechanism is not through immunogenic cell death. Furthermore, this study can broadly contribute to the development of dichloroacetate-loaded silver nanoparticles and the design of targeted pharmacological formulations to fight melanoma and other types of cancer [11].

Conflicts of Interest

The authors declare that they have no conflicts of interest.

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