World Academy of Science, Engineering and Technology
International Journal of Mathematical and Computational Sciences
Vol:14, No:12, 2020

Quantum Dots Incorporated in Biomembrane Models for Cancer Marker

Authors : Thiago E. Goto, Carla C. Lopes, Helena B. Nader, Anielle C. A. Silva, Noelio O. Dantas, José R. Siqueira Jr., Luciano Caseli

Abstract : Quantum dots (QD) are semiconductor nanocrystals that can be employed in biological research as a tool for fluorescence imagings, having the potential to expand in vivo and in vitro analysis as cancerous cell biomarkers. Particularly, cadmium selenide (CdSe) magic-sized quantum dots (MSQDs) exhibit stable luminescence that is feasible for biological applications, especially for imaging of tumor cells. For these facts, it is interesting to know the mechanisms of action of how such QDs mark biological cells. For that, simplified models are a suitable strategy. Among these models, Langmuir films of lipids formed at the air-water interface seem to be adequate since they can mimic half a membrane. They are monomolecular films formed at liquid-gas interfaces that can spontaneously form when organic solutions of amphiphilic compounds are spread on the liquid-gas interface. After solvent evaporation, the monomolecular film is formed, and a variety of techniques, including tensiometric, spectroscopic and optic can be applied. When the monolayer is formed by membrane lipids at the air-water interface, a model for half a membrane can be inferred where the aqueous subphase serve as a model for external or internal compartment of the cell. These films can be transferred to solid supports forming the so-called Langmuir-Blodgett (LB) films, and an ampler variety of techniques can be additionally used to characterize the film, allowing for the formation of devices and sensors. With these ideas in mind, the objective of this work was to investigate the specific interactions of CdSe MSQDs with tumorigenic and non-tumorigenic cells using Langmuir monolayers and LB films of lipids and specific cell extracts as membrane models for diagnosis of cancerous cells. Surface pressure-area isotherms and polarization modulation reflection-absorption spectroscopy (PM-IRRAS) showed an intrinsic interaction between the quantum dots, inserted in the aqueous subphase, and Langmuir monolayers, constructed either of selected lipids or of non-tumorigenic and tumorigenic cells extracts. The quantum dots expanded the monolayers and changed the PM-IRRAS spectra for the lipid monolayers. The mixed films were then compressed to high surface pressures and transferred from the floating monolayer to solid supports by using the LB technique. Images of the films were then obtained with atomic force microscopy (AFM) and confocal microscopy, which provided information about the morphology of the films. Similarities and differences between films with different composition representing cell membranes, with or without CdSe MSQDs, was analyzed. The results indicated that the interaction of quantum dots with the bioinspired films is modulated by the lipid composition. The properties of the normal cell monolayer were not significantly altered, whereas for the tumorigenic cell monolayer models, the films presented significant alteration. The images therefore exhibited a stronger effect of CdSe MSQDs on the models representing cancerous cells. As important implication of these findings, one may envisage for new bioinspired surfaces based on molecular recognition for biomedical applications.

Keywords : biomembrane, langmuir monolayers, quantum dots, surfaces
Conference Title : ICSRD 2020 : International Conference on Scientific Research and Development
Conference Location : Chicago, United States
Conference Dates : December 12-13, 2020