Assessing nanoscale physiometacomposite enzyme interfaces for fluorescent and luminescent bioimaging

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Physiologically based nanoparticles (NPs) could likely be administered to animals and be used for fluorescence or bioluminescence based imaging and other biomedical applications. First generation quantum dots were derived of non-physiological elements and their fluorescence range was in the ultraviolet to visible range where most biological fluids and tissues interfere and fluorescence quenching is most severe limiting. To circumvent this, NPs or their more novel composites, physiometacomposite (PMC) materials loaded with Beta-galactosidase (B-Gal) or Luciferase (Luc) were high throughput screened to investigate their fluorescence or bioluminescence output as potential nanobio sensors. Thirty-one NPs were incubated with 200 μg/ml of β-Gal in a 2:1 substrate ratio in a 96-well plate at three different NP concentrations (5, 50, and 400 μg/ml). Thirteen NPs gave off fluorescent readings in the 10^8 units with a dynamic range of 10^5-10^6 above background. In a parallel experiment with Luc, we identified two PMC, iron zinc oxide sulfide (FeZnS) and manganese zinc oxide sulfide (MnZnS), which produced the highest bioluminescence ($\geq 9.3 \times 10^6$ RLUs/well). The literature suggests that cells tolerate PMC doses up to 50 μg/ml. Time-course experiments demonstrate luminescence production up to 1 hour when incubated in buffer. Zeta potential measurements suggest a strong interaction with enzyme on the surface of these PMC. We expect to be able to ligate protein or RNA-based targeting agents to the surface of the PMC as co-conjugates with enzyme in order to specifically label cancer cells. Once firmly established, the prototype PMC nanobio sensors will be tested for tumor and metastasis imaging in our experimental mouse melanoma model.

Research Grant: Boehringer Ingelheim Veterinary Scholars
Student Support: KSU CVM Office of Research