Toward Graphene-Based Imaging and Drug-Delivery Agents for Breast Cancer:
Cytotoxicity of Graphene Oxide Nanoribbons in Human Breast Cancer Cell Lines

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Background: Over the course of two months, we had the opportunity to conduct science research in the Multi Functional Nano & Supra Molecular Biosystems Laboratory at SUNY Stony Brook through the Students and Scientists High School Internship Program sponsored by the Huntington Breast Cancer Action Coalition, Inc. and the Great Neck Breast Cancer Coalition.

Objective: The aim of this internship was to give students the unique opportunity to engage in authentic science research. The focus of the research was to study the cytotoxicity of graphene oxide nanoribbons on human breast cancer cell lines MCF-7 and SkBr.

Work performed: To accomplish the objective the effects of different dilutions of graphene oxide nanoribbons on the different functions of MCF-7 and SkBr breast cancer cells were investigated. Graphene oxide nanoribbons are a type of carbon-based nanoparticle that has potential to revolutionize the field of nanomedicine. These nanoparticles are currently being explored for their potential medical applications, such
as multi-functional platforms for molecular imaging of breast cancer tumors and targeted
drug-delivery agents to improve the accuracy and efficiency of breast cancer treatment.
Before these nanoribbons can be used for biomedical applications, their toxicity needs to
be evaluated. Thus, as a first step, *in vitro* cytotoxicity studies have been conducted to
determine to identify their CD$_{50}$ value, i.e. the concentration of graphene oxide
nanoribbons at which half of the initial cells remain viable. The cytotoxicity was
determined through the use of four colorimetric assays: Neutral red, Alamar Blue, Lactic
dehydrogenase (LDH), and the Water Soluble Tetrazolium-1 (WST-1) assay. To further
validate the assessment, a non-colorimetric assay was also used. There were 6 trials
conducted for each concentration of 0, 1, 10, 50, 100, 250, 400, and 500 µg GONR/mL
DSPE-PEG. Our results show that the CD$_{50}$ value of the graphene nanoribbons was
between 100 and 250 µg/mL. Preliminary investigations also show that concentrations of
less than 50 µg/mL do not affect the cell machinery, and that these dosages maybe be safe
for the *in vitro* studies to test their efficacy as imaging and drug delivery agents.

**Conclusions:** Through this experience, we gained an understanding of the research
process and the importance of cytotoxicity studies before a product can be used for
biomedical applications, such as drug delivery and medical imaging contrast agents. Our
results showed that the CD$_{50}$ value was 100 µg/ml of graphene oxide nanoribbons after
48 hours of exposure. This preliminary research is necessary to lower the likelihood of
negative side effects when these nanoparticles are studied further as multi-functional
platforms for molecular imaging of breast cancer tumors and targeted drug-delivery
agents to improve the accuracy and efficiency of breast cancer treatment.