Effect of Microgravity on Nanoparticle-Cellular Interaction

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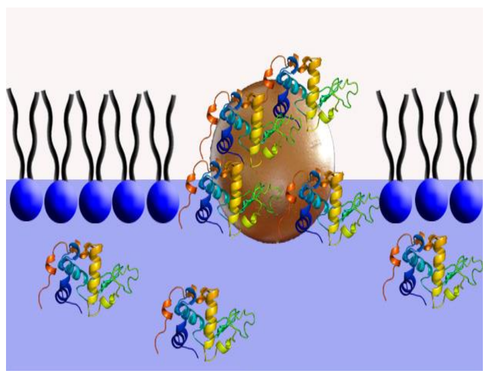
SSEP Mission 12 to the ISS

The Student Spaceflight Experiments Program (SSEP) is conducting its 12th mission to the International Space Station (ISS). This offers students from the United States, Canada, and Brazil to design a significant experiment that tests the effects of microgravity, an experience that is not possible on Earth. Eight proposals from The University of Bridgeport were submitted for review to the National Aeronautics and Space Administration (NASA), and this is the winning proposal that will enter the ISS in the late spring of 2018.

Abstract

A cell contains numerous proteins on its surface and in the cytoplasm that carry out a variety of functions. Maleimide – functionalized Graphene quantum dots (m-GQDs) have the ability to attach or "tag" both cell surface and intracellular proteins in the gravitational setting. Such quantum dots have photoluminescent properties, which can be utilized for tagging the cysteine residue on the proteins and hence in the bio-imaging applications of these proteins.



` This experiment proposes whether m-GQDs will have a stable binding to cellular proteins on Chinese Hamster Ovary (CHO) mammalian cells under the influence of microgravity. If this occurs, it can provide a wide variety of applications for studying the effects of micro gravity on a physiological system in the way proteins behave compared to a gravitational setting. The basic principle of this procedure can be further utilized to study many more cellular processes under the influence of microgravity by simply tracking these "tagged" cellular proteins under a fluorescence microscope.

Questions to be Addressed

- Will GQDs bind to cellular proteins under the micro-gravity setting?
- If GQDs bind to cellular proteins under micro-gravitational conditions, would there be any differences in the number of proteins bound?
- Will there be largely surface proteins bound or intracellular proteins bound or both?

Mini Lab Setup

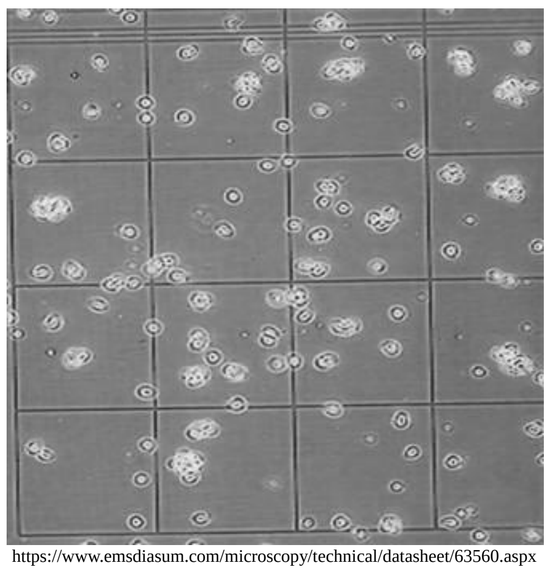
- **Volume 1**: Fixed Chinese Hamster Ovary (CHO) mammalian cells- 90,000 cells in 3mL
- **Volume 2**: Graphene Quantum Dots with maleimide functionality in distilled water in 6mL

Proposed Timeline of Crew Interaction

Day	Interaction
A = 0	Open clamp A, and shake gently for 10 seconds
A + 2	No interaction requested
U – 14	No interaction requested
U – 5	No interaction requested
U – 2	No interaction requested

Experimental Design

- Chinese Hamster Ovary (CHO) cells will be cultured, counted on a Hemocytometer, and fixed according to protocol.
- 90,000 CHO cells will be placed in 3mL of distilled water.
- Graphene Quantum Dots (GQDs) with maleimide functionality will tag the cysteine groups of proteins on and inside of the cell.

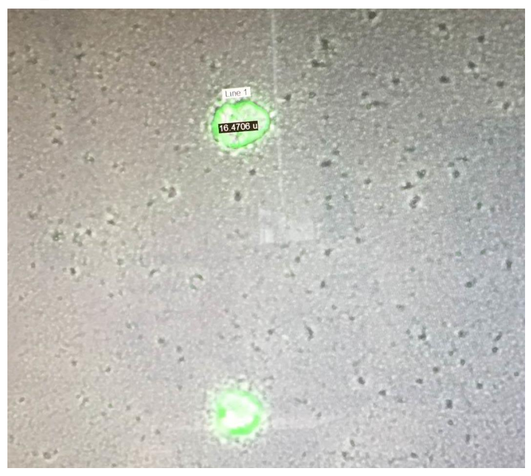


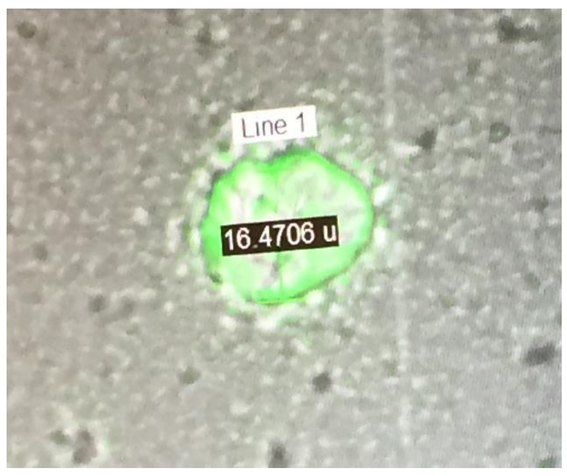
https://www.emsdiasum.com/microscopy/technical/datasheet/63560.aspx

- The fixed CHO cells in compartment 1 and GQDs in compartment two will be separated until 2 days after reaching the ISS.
- When returning to Earth, the mixture will be analyzed.

Results

- Results will be calculated using a second cell count post-treatment and through bio imaging techniques.
- The figures below represent a successful binding of m-GQDs to the cysteine groups of proteins on and inside of a CHO cell on Earth, identified on a fluorescence microscope due to its known size of about 14μm -17μm.
- This is what we will be looking for when the samples return from space.





Possible Conclusions

- Maleimide graphene quantum dots, on earth and in the presence of gravity, possess the ability to enter, and bind the cysteine groups on the proteins, which can then be fluoresced and studied.
- If this m-GQD does not lose its ability to enter and bind the cell's proteins in space, then the number and type of proteins tagged will be studied when the sample comes back from space.
- If m-GQDs do not bind in a stable manner to the proteins while under micro-gravity conditions, that will open the door for investigating possible roles of gravity in cellular interactions.

Our goal is to study cell physiology in space. We know in space, the absence of gravitational force will have a tremendous influence on life, especially at the cellular level. Life as we know it, is almost entirely made of proteins and if we know the effect of gravity on the various proteins that make up cells, then we could have a better understanding of how the cell functions in space.

Acknowledgements

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