Modeling radiation dose and biological effects in diagnostic and therapeutic nuclear medicine

HYPOTHESIS:
Patients undergoing nuclear medicine procedures are injected with radiopharmaceuticals that emit radiations that are used for therapeutic purposes. Unlike the relatively uniform radiation exposures that are encountered with external beams of radiation that are commonly used in radiation oncology, the radiation exposures received in nuclear medicine are often highly nonuniform. The nonuniform distribution of dose can have a profound effect on the response of the targeted tissue. Therefore, to create treatment plans for therapeutic radiopharmaceuticals, there is a need for software tools that can calculate the distribution of radiation dose in tissues and accurately predict the response of the tissue. It is hypothesized that a user-friendly software tool can be created that will allow individuals with limited expertise to model and observe tissue responses to radiopharmaceuticals on a cell-by-cell basis.

PROJECT DESCRIPTION (Include design, methodology, data collection, techniques, data analysis to be employed and evaluation and interpretation methodology)

This project requires a student with a computer science or engineering background that is interested in simulation applications in medicine. Java will be used to create an intuitive graphic user interface that will enable the user to first choose the radionuclide and its spatial distribution in a three-dimensional multicellular cluster. The computer program will then calculate the radiation absorbed dose in each cell of the cluster, taking into account the self-dose deposited by radiations emitted from radioactivity within the same cell and cross-dose deposited by radiations emitted from radioactivity in surrounding cells. Radiobiological modeling will then be undertaken to predict the fate of each cell in the multicellular cluster and calculate the fraction of cells that survive the radiation insult. Unlike wet-lab based projects that require extensive hours at the laboratory bench, this project will enable the student to apply their creative talents in the virtual world of computing, an area of increasing importance in the delivery of health care. It is anticipated that successful completion of the project will lead to a publication in a major journal.

SPONSOR'S MOST RECENT PUBLICATIONS RELEVANT TO THIS RESEARCH:

Summer Student Research Program
Project Description


IS THIS PROJECT SUPPORTED BY EXTRAMURAL FUNDS?
   Yes ☐ or No ☒
   (IF YES, PLEASE SUPPLY THE GRANTING AGENCY’S NAME)

THIS PROJECT IS: ☐Clinical ☐Laboratory ☒Behavioral ☒Other

THIS PROJECT EMPLOYS RADIOISOTOPES ☐

THIS PROJECT INVOLVES THE USE OF ANIMALS ☐
   PENDING ☐ APPROVED ☐ IACUC PROTOCOL #

THIS PROJECT INVOLVES THE USE OF HUMAN SUBJECTS ☐
   PENDING ☐ APPROVED ☐ IRB PROTOCOL # M

WHAT WILL THE STUDENT LEARN FROM THIS EXPERIENCE?

Creation of intuitive graphic user interfaces for biomedical applications. Knowledge of types of ionizing radiation used in radiology and radiation oncology. Knowledge regarding the manipulation and control of radioactive materials for medicinal applications. Radiation safety.