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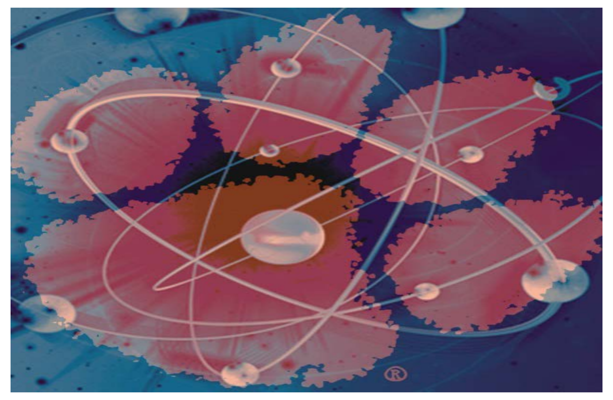
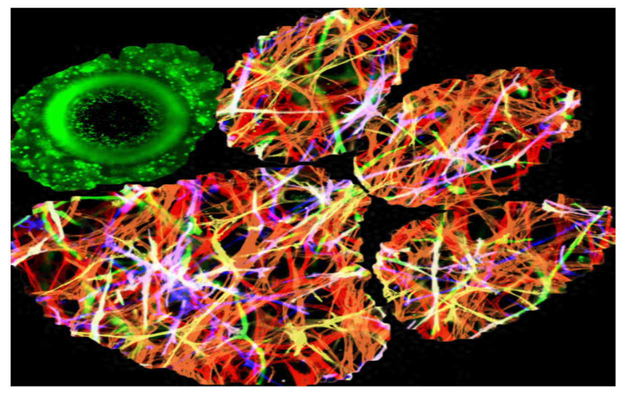


Generation and Characterization of Radiation in Biomedical Applications



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Introduction

- For more than a hundred years, photon radiation has proved to be an invaluable tool in bio-medical uses from imaging to clinical treatments
- While extremely helpful, it has also been observed that radiation can also have long term negative side effects, often unseen until years later
- With advances in bio-engineering and atomic physics, as well as advances in observational devices, this research will look more closely at the relationship between photon radiation and cellular structure at the atomic level

Previous Research

- Articular cartilage was exposed to x-ray radiation at different doses to observe how it affects physical and mechanical properties
- Cartilage samples were exposed to various dose levels at 2, 5 and 10 gray (Gy)
- The most cartilage damage and cell death was observed at 10Gy
- The 2Gy sample didn't show cell death the but the dose was still enough to drop the modulus of tissue by more than a factor of 2

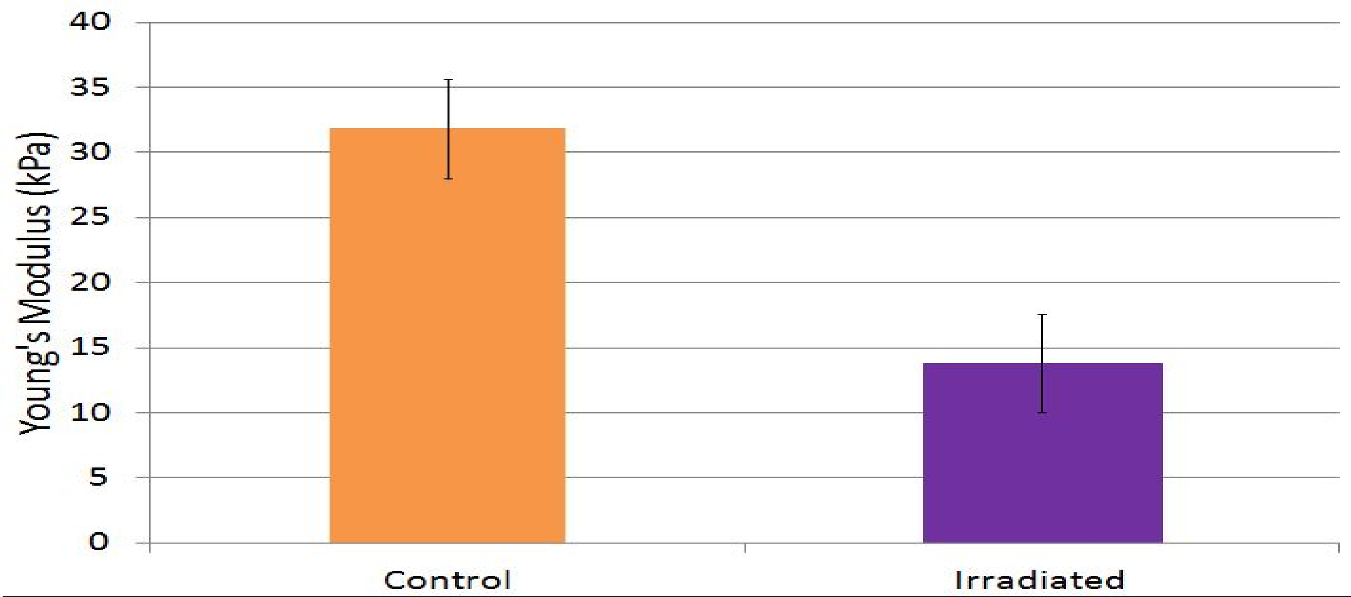
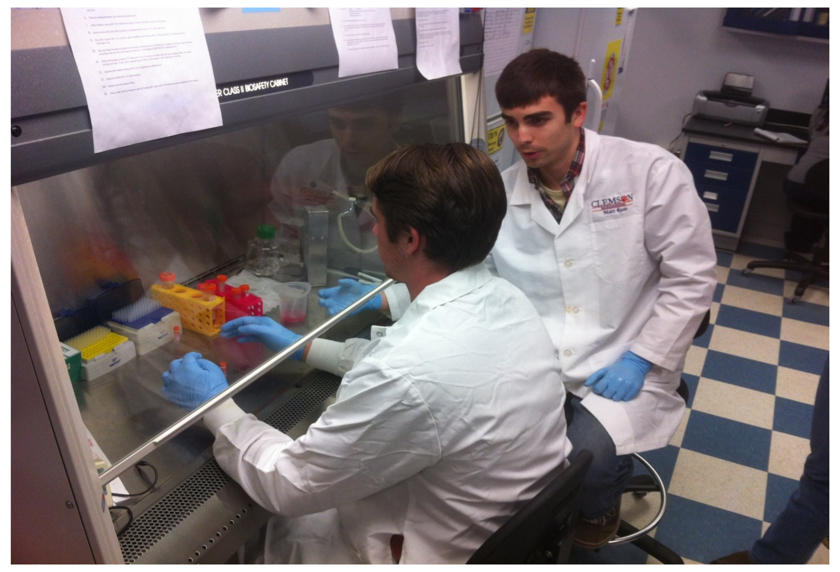


Figure 1. Elastic modulus of cartilage before and after radiation.

Methods & Materials

- Populations of cells ranging from 3T3 fibroblast to cancer cells are grown in a T75 flask and incubated in media that supplies nutrients for the cells until passaging is necessary
- The cells are checked daily and passaged about every four days so that they grow healthy and properly in preparation to be irradiated
- The Clemson University Electron Beam Ion Trap (CU-EBIT) will be used as a source for ions which are then used to create monochromatic x-rays that will be used to irradiate the prepared cell cultures
- The CU-EBIT is the most advanced of only two ion traps/sources in the entire country. Until now, it has only been used for non-biomaterial research

Figure 2. (right) Students passaging cultured cancer cells.



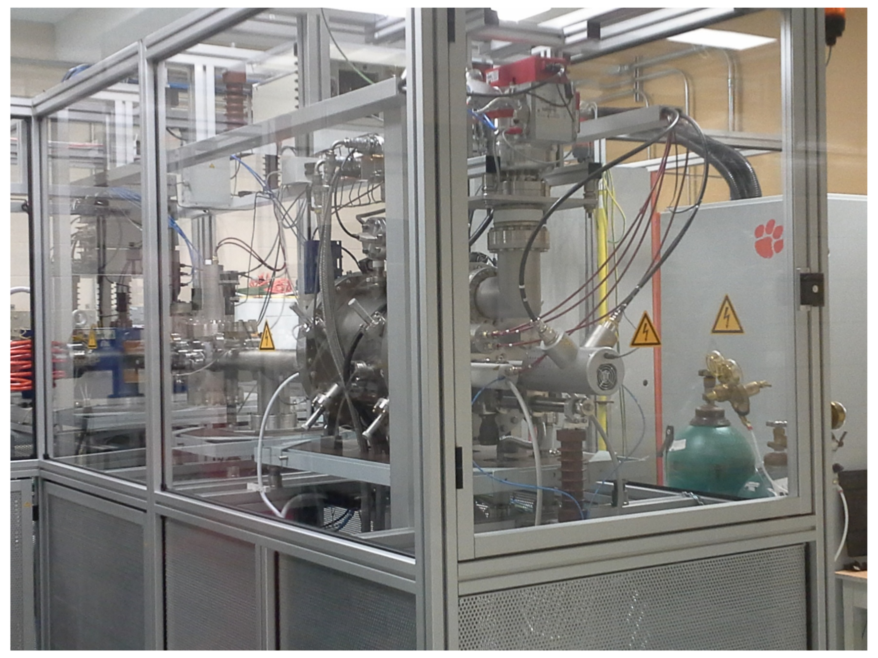
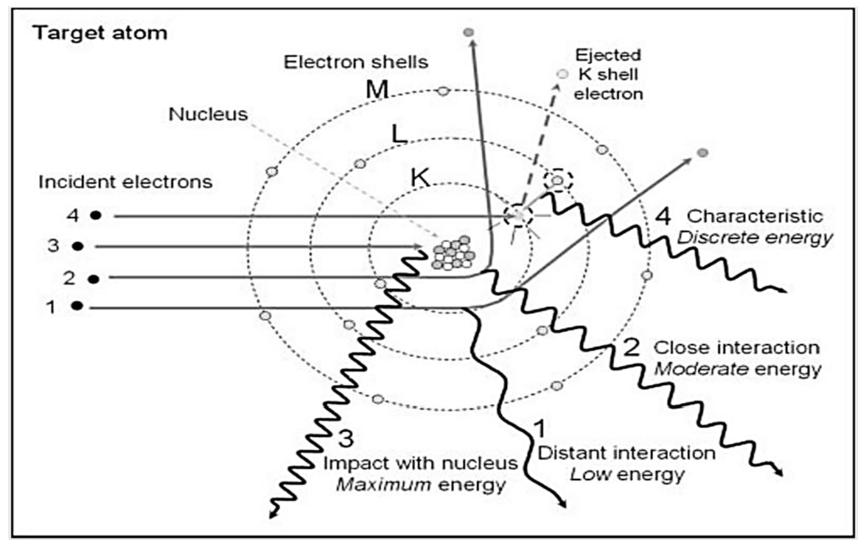
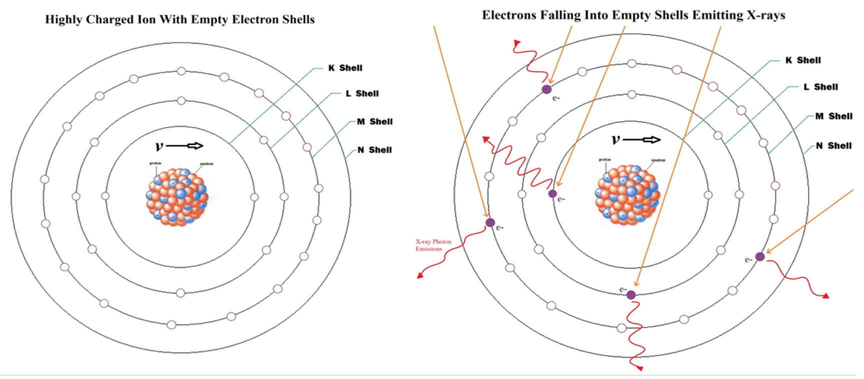


Figure 3. (left) The CU-EBIT ion source.



In traditional x-ray generation, high energy electrons are propelled toward material, and the interactions with the already present electrons as well as the nucleus create a broad band of x-ray emission energy levels. Currently, the only moderating factor used in both research and clinical settings is in controlling the amount exposure time to the emitted photons, measured in units of grays. A gray is defined as the absorption of one joule of radiation energy by a kilogram of matter.



This newly proposed method for research purposes is to use "large" atoms that have been stripped of most of their electrons, to be propelled toward a target area. As the ion approaches a material or cloud of electrons, it begins to pull electrons into its empty electron shells, emitting photons of characteristically specific quantized energies in the form of x-rays. With the use of specific highly charged ions from the CU-EBIT, along with chosen filters, only monochromatic x-rays will be allowed to reach the test material. This method of research should yield significant data that will allow a greater understanding of how x-rays interact with biological materials at the atomic level.

Goals

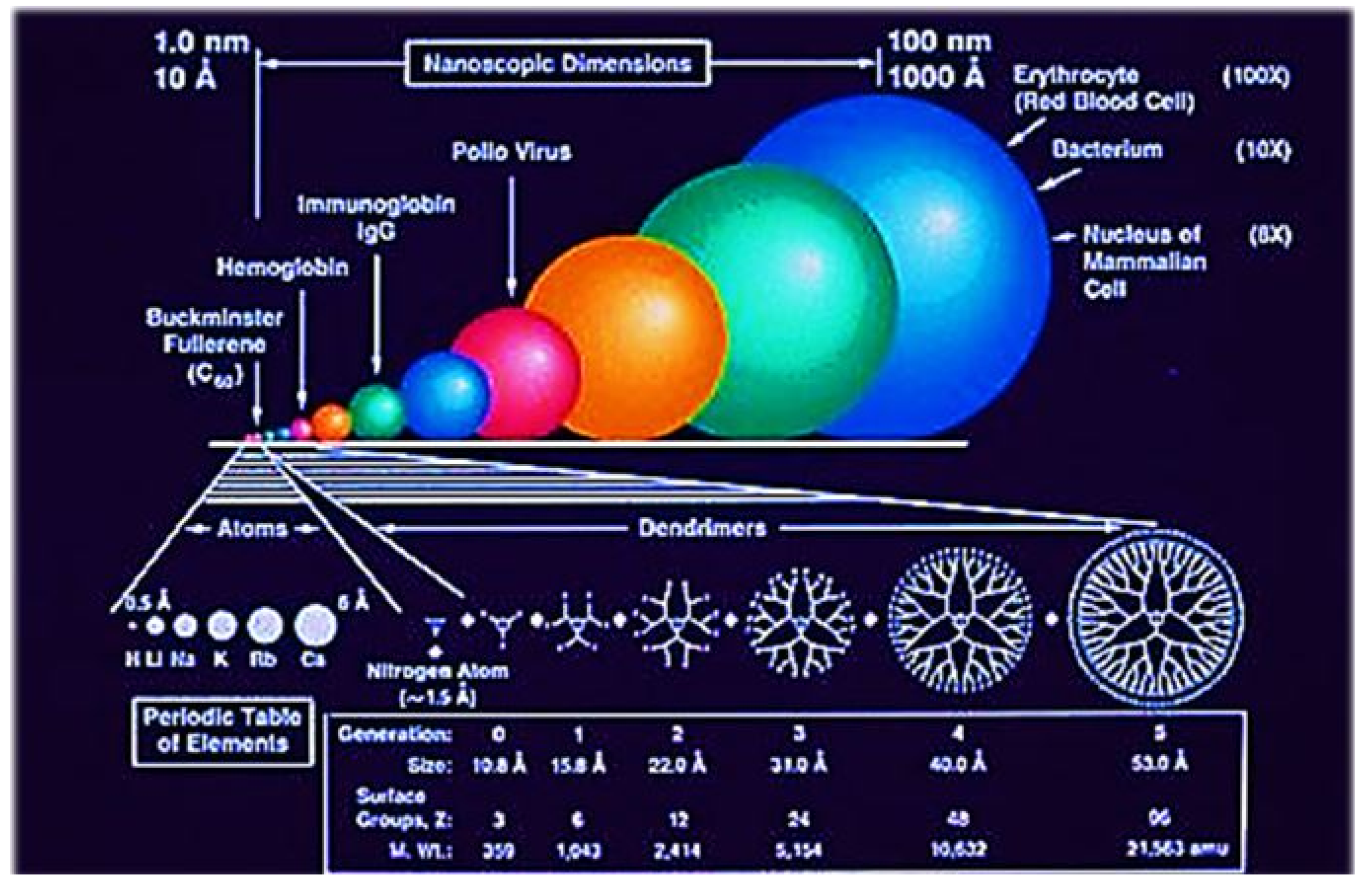


Figure 4. Size scale relation from atom to blood cell.

Goal: To understand how different types of ionizing radiation affect tissues.

- To grow cell samples on various materials in good health and prepare them to be irradiated and observe any effects caused by the radiation
- To experimentally test the CU-EBIT's ability to create monochromatic x-rays
- To observe and collect data that will help to better understand the effects of radiation on cellular and molecular structures at the atomic level
- That this research will one day improve the safety and effectiveness of all imaging and therapy devices that employ electromagnetic radiation

References and Acknowledgements

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- http://www.pivot.net/~jpierce/nanotechnology.htm
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