The Effects of High Energy Particles on DNA Strand Breakage

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A series of experiments to investigate the effects of cosmic radiation on DNA has been initiated. This is accomplished by examining the DNA strand breakage due to exposure to high-energy particles. Supercoiled pBR322 plasmid DNA is used. This DNA is exposed in a dried form on Acramica Aramid, and in a solution with distilled, deionized, autoclaved water in polyethylene packets. In its natural state, this double stranded DNA molecule is in a supercoiled form. When a single strand break occurs, the molecule relaxes into a circular form. When a double strand break occurs, the molecule becomes linear. The different DNA forms are detectable using agarose gel electrophoresis. The three different forms separate into three distinct bands in the gel. In addition to this, the size of the linear fragments is an indication of the number of double stranded breaks per molecule. This can be measured using acrylamide gel electrophoresis. The DNA fragments separate according to size.

In December, a Kr 84 (+11) beam was used to irradiate 20μmol samples of dried pBR322. The pBR322 samples were exposed to different particle levels, ranging from 5.39E6 to 1.08E10 particles. At the lower levels, there was no significant breakage of the DNA. But as the amount of particles increased, so did the damage. At the highest level of exposure, the DNA structures were evenly distributed between the three forms. After the agarose gels, acrylamide gels were run to investigate the size of the linear fragments. An 8% acrylamide gel was run. Distinct bands were noticed near the wells, but bands did not extend down the lanes. This indicated that the DNA fragments were very large, and the occurrence of multiple double stranded breaks per molecule was rare.

In April, an Fe and O beam were used to irradiate 25μmol samples of dried pBR322. Ten samples were exposed only to Fe and received particle dosages between 1.8E3 to 1.8E8. Ten more samples were exposed to only O and received particle dosages between 1.8E3 and 1.8E8. A third set of ten samples were exposed to both Fe and O at the above particle levels. Data from NASA's Advanced Composition Explorer Satellite were used when determining the particle identity and level of exposure. Analysis of these samples is in progress.

In May, an Fe and O beam will be used to irradiate DNA samples that are in solution. These results will provide insight into the effects of free radicals and secondary events. The possibilities of using other beams and live cell cultures is being explored for future runs.