DNA Breaks From Neutron Radiation

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UM Physics REU 2012
Types of Radiation

- Non-Ionizing
- Ionizing
  - Alpha
  - Beta
    - β +
    - β -
  - Gamma Rays
  - X-rays
  - Neutrons

http://sabinpr2.blogspot.com/2012_05_01_archive.html
Radiation Risks

- Linear No Threshold
- Threshold

Dose

- Absorbed Dose
- Kerma
- Dose Equivalent \( H = QF \times D \)
- Effective Dose Equivalent
- Effective Dose

<table>
<thead>
<tr>
<th>Type of radiation, R</th>
<th>Energy range</th>
<th>Quality or weighting factor, ( w_R )</th>
</tr>
</thead>
<tbody>
<tr>
<td>Photons, electrons</td>
<td>All energies</td>
<td>1</td>
</tr>
<tr>
<td>Neutrons</td>
<td>&lt;10 ( \text{keV} )</td>
<td>5</td>
</tr>
<tr>
<td></td>
<td>10–100 ( \text{keV} )</td>
<td>10</td>
</tr>
<tr>
<td></td>
<td>100 ( \text{keV} )–2 ( \text{MeV} )</td>
<td>20</td>
</tr>
<tr>
<td></td>
<td>2–20 ( \text{MeV} )</td>
<td>10</td>
</tr>
<tr>
<td></td>
<td>&gt;20 ( \text{MeV} )</td>
<td>5</td>
</tr>
<tr>
<td></td>
<td>&lt;20 ( \text{MeV} )</td>
<td>5</td>
</tr>
<tr>
<td>Protons</td>
<td>Alpha particles, fission</td>
<td>20</td>
</tr>
<tr>
<td></td>
<td>fragments, heavy nuclei</td>
<td>20</td>
</tr>
</tbody>
</table>
Neutron Radiation

- **Sources**
  - Fission
  - Generators
  - Solar Flares
  - Cosmic Rays

- **Interactions**
  - Nuclear Accidents
  - Nuclear Terrorism
  - Space Travel

UM d-t Neutron Generator
DNA & Damages

- Plasmid DNA
- Single Strand Breaks
- Double Strand Breaks
Set Up at UM Nuclear Engineering:

DNA Sample Holder  Neutron Generator
Neutron Flux

Flux Rate
\[ \Phi = \frac{N}{4\pi r^2} \]

Point Source with a Shield
\[ \Phi^0 = \Phi e^{-\sum_{\text{ont}}} \]

Kerma
\[ K = 1.602 \times 10^{-10} E \left( \frac{f_s(E)\mu_{n,\gamma}(E)}{\rho} \right) \Phi \]

Approx. Dose
\[ Time = \frac{D}{K} \]
Larger fragments travel more slowly because they experience more drag in the gel.

More DSBs will create smaller fragments causing them to move farther in the gel.
Gel Scans

Above: scan of stained gel
Left & Right: intensity peaks

Gels and samples were prepared in lab, photographed and analyzed using NIH ImageJ
Conclusions

- Threshold effect?
- Not a point source?
What’s next?

- Retesting with new block placement
- New cylindrical block
- Dose estimates from neutron activation
- Human heart cells
- γ H2AX analysis
Thanks to:

- Fredrick Becchetti
- Mike Febbaro
- Ramon Torres
- Michael Hartman
- Bruce Pierson
- Chris Meiners
- Julia Bourg
- Joel Revalee
- Jim Liu
- UM Physics
- NSF