RADIATION SAFETY

Working Safely with Radiation

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How most of us (Medical Technology) feel about radiation until we understand the principles of safe use:
Learning Outcomes:

At the end of the presentation, students should:

1. Define the radiation.
2. Define the radioactivity.
3. Describe atomic structure.
4. Describe general consideration when working in the lab.
5. Describe the types of radiation.
6. Define the radiation spectrum.
8. State the general considerations for radiation safety.
9. Describe the types of badges available
10. Define ALARA system.
11. State the radiation detectors.
What is Radiation?

**Radiation**: energy in motion either in the form of particles or electromagnetic.

**Radioactivity**: spontaneous emission of radiation from the nucleus of an unstable atom.
The atom is comprised of a nucleus, which is made up of positively charged protons and electrically neutral (no charge) neutrons, surrounded by negatively charged electrons.

In an electrically neutral atom, the number of positively charged protons and negatively charged electrons are equal.
Types of Radiation

Ionizing Radiation
- A radiation that has sufficient energy to remove electrons from atoms or molecules as it passes through matter.
- Examples: x-rays, gamma rays, beta particles, and alpha particles

Non-Ionizing Radiation
- A radiation that is not as energetic as ionizing radiation and cannot remove electrons from atoms or molecules.
- Examples: visible light, UV light, lasers, heat, radio waves, infrared light microwaves, and radar
Ionizing radiation - Types

Internal - Inhalation
- Ingestion

External - Skin
- Eye
- Tissue
Radiation from High to Low Frequency
Radiation and Radioactive Material are a Natural Part of Our Lives

- **Natural:**
  - We are constantly exposed to low levels of radiation from outer space, earth, and the healing arts.

- **Environmental:**
  - Low levels of naturally occurring radioactive material are in our environment, the food we eat, and in many consumer products.

- **Man-made:**
  - Some consumer products also contain small amounts of man-made radioactive material.
RADIOACTIVE SOURCES

Solar Radiation
Consumer Products
Radioactive Waste
Terrestrial Radiation
Food & Drink
Nuclear Power
Cosmic Ray
Radon
Nuclear Medicine
X-Ray
Radiation exposure usually results from:

1. Diagnostic radiology, including diagnostic X-ray (Bone)
2. Therapeutic radiology: the emission radiation by patients who are being treated with radio-nuclides
3. Oncology (Cancer)
5. Animal research study.
General Considerations

1- Obtain appropriate certification or permission for the use of the specific radioactive substances by attending and passing special courses on the use and handling of radioactive materials.

2- To use any type of radioactive materials personal protective equipment must be used including.

3- Always wear radioactivity-monitoring film badge whenever working with radioactive materials.

4- Area used for radioactive work must be separate from the rest of the lab with proper labeling of radioactive hazard warning.

5- The bench used for radioactive work must have double bench coat, the top one must be absorbent.
Appropriate Lab Attire

- Double disposable gloves
- Over-shoes
- Collar-type ankle-length lab coat
- Eye-protection (glasses, goggles)
- Face mask
- Disposable head-cover
- Disposable gown or apron
6- All equipment and materials (eg. Pipettes, beakers, flasks, tubes, water bath, mixers, centrifuges) used for radioactive work must be labeled as such and should not be used for other purposes.

7- Monitor the work area before and after work with suitable radioactive detector.

8- Wipe-off any radioactive contamination with a suitable detergent and check for radioactivity

9- Dispose of radioactive waste as detailed in the waste disposal section.

10- Never exceed the allowed limit of radioactivity assigned for use

11- Deal with accidents promptly and report to safety officer
Radiation use will be labeled on door, work area & storage area

Research laboratories work with very low levels of radioactive materials

Safety can check for potential contamination prior to work in a lab that uses radioactive materials

As a precaution: wear gloves, safety glasses and wash hands
Medical Treatment

- External Decontamination
  - Mild cleaning solution applied to intact skin
    - Betadine, Soap, Rad-Con for hands
  - Never use harsh abrasive or steel wool

- Internal Decontamination
  - Treatment which enhances excretion of radionuclides
### Annual Radiation Exposure Limits

**Occupationally Exposed Worker:**

<table>
<thead>
<tr>
<th>Radiation Type</th>
<th>rem</th>
<th>mrem</th>
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</thead>
<tbody>
<tr>
<td>Whole body</td>
<td>5</td>
<td>5000</td>
</tr>
<tr>
<td>Eye</td>
<td>15</td>
<td>15,000</td>
</tr>
<tr>
<td>Shallow</td>
<td>50</td>
<td>50,000</td>
</tr>
<tr>
<td>Minor</td>
<td>0.5</td>
<td>500</td>
</tr>
<tr>
<td>Pregnant Worker</td>
<td>0.5*</td>
<td>500*</td>
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</tbody>
</table>

*9 months
Types of Badges Available

Luxel Dosimeter

Ring Dosimeter

0 rad
10 rad
100 rad
2 rad
25 rad
200 rad
5 rad
50 rad

EFFECT OF DOSE
Radiation Protection from Exposure: ALARA

- **As Low As Reasonably Achievable**

- **How?**
  - Time
  - Distance
  - Shielding

- **Why?**
  - Minimize Dose
Less time = Less radiation exposure

Use radioactive material only when necessary

Dry runs (without radioactive material)

Identify portions of the experiment that can be altered in order to decrease exposure times

Shorten time when near radioactive material

Obtaining higher doses in order to get an experiment done quicker is NOT “reasonable”!
Distance

- Effective & Easy
- Inverse Square Law
  - Doubling distance from source, decreases dose by factor of four
  - Tripling it decreases dose nine-fold
- More Distance = Less Radiation Exposure
- Tongs, Tweezers, Pipettes, Pliers
Shielding

- Materials “absorb” radiation
- Proper shielding = Less Radiation Exposure
- Plexiglass vs. Lead
Shielding Examples
Radiation Shielding

- Shielding used where appropriate
- Significantly reduces radiation effects
Radiation Detectors

- General Classes of Detectors
  - Gas-Filled Detectors
    - Geiger-Mueller Counters
  - Solid Detectors
  - Liquid Detectors
Risk from a radiation dose is typically based on calculations of the “real” effect of the radiation dose that is absorbed.

These calculations are based on:

- The type of radiation.
  - Each type of radiation is different and affects tissues differently.
- The energy that it leaves in the body.
  - More energy means a higher probability of an effect.
- Where in the body the energy remains.
  - Radiation exposure to a non-sensitive area of the body (i.e., wrist) really has no actual effect. Radiation exposure to a sensitive area of the body (i.e., blood-forming organs) can have an effect if the amount of energy left is high enough.
Effects of radiation

- Exposure to radiation can affect the body in a number of ways, and the adverse health effect of exposure may not be seen for many years.

- The time after exposure until possible cancer formation is called the “latent period.”

- Cancer of various organs which are exposed to radiation:
  
  - Skin cancer
  - Spleen cancer
  - Pancreatic cancer
  - Leukemia
Effects of radiation

- Congenital abnormalities;

- *Body deformities*: effect the fetus resulting in body deformities (e.g. hands, legs, liver, eyes, fingers … etc)

- *Internal organs deformities*: effect the fetus’s internal organs resulting in internal organs deformities (e.g., lungs, liver, spleen … etc.)

- *Genetic effect*: results in gene mutation of the exposed person which is transformed to his off-springs and many last for generations