Western University of Health Sciences
The discipline of learning. The art of caring.

Donald E. Walters, Ph.D.
Manager, Office of Research Regulatory Affairs
909-469-5592

ANNUAL RADIATION SAFETY REFRESHER TRAINING

Welcome to Western University of Health Sciences' (WesternU) Annual Radiation Safety Refresher Training. There has never been an injury from radioactive material at WesternU and the University is committed to maintain this safety record.

The use of radioactive material at WesternU is governed by Title 17 of the California Code of Regulations which includes, by reference, parts of Title 10 of the Code of Federal Regulations. The regulations mandate that WesternU establish a Radiation Safety Committee (RSC) and appoint a Radiation Safety Officer (RSO) and an Alternate RSO and that "Each licensee shall develop, document and implement a radiation protection program commensurate with the scope and extent of licenses activities…" The RSC and RSO assume overall responsibility for the Radiation Safety Program. The RSO reports directly to the VP for Research and Biotechnology.

In addition to the initial radiation safety training required of all laboratory personnel, Los Angeles County Department of Public Health requires that all persons working with or handling radioactive material or radiation producing equipment receive and document annual radiation safety refresher training. A review of the information contained in this document is intended to meet this requirement.

RADIOACTIVE MATERIAL LICENSE

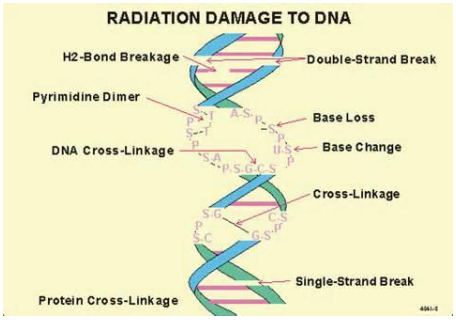
WesternU's Radioactive Material License (RML) is issued by the Radiologic Health Branch of the State of California, Department of Public Health. Information contained in the license includes, but is not limited to, the following:

- Nuclides the University is permitted to possess along with the form and possession limits for each nuclide.
- Manner in which nuclides may be used (*in vitro* vs *in vivo*).
- Locations at which nuclides may be used.
- Names of persons authorized to use nuclides.
- Approved amendments, by reference, to the license.
- Names of the Radiation Safety Officer (RSO) and Alternate RSO.

Persons listed in item #12 of the RML as authorized users of radioactive material are responsible for all other persons using radioactive material under their supervision.

HEALTH EFFECTS OF RADIATION EXPOSURE

Ionizing radiation is of particular concern. Ionizing radiation has sufficient energy to remove electrons from other atoms and, in mammalian cells, this may directly damage DNA or it may lead to the formation of free radicals which are atoms or molecules with a single unpaired electron. Free radicals are highly reactive with various cell components and can result in abnormal cell function or cell death.



Stochastic effects are those in which the probability of an effect occurring increases with dose without requiring a minimum threshold (dose) to cause an effect. Carcinogenic effects are examples. Cataracts, skin ulcerations or burns, depletion of blood forming cells in bone marrow and impairment of fertility are examples of non-stochastic effects.

Except for high energy gamma particles, ionizing radiation is weakened as it passes through living tissue and deeper tissues generally receive a lower dose than shallower tissues from external sources of radiation.

AS LOW AS REASONABLY ACHIEVABLE

Based on the concept that radiation-induced cancer is a risk regardless of how low the radiation dose is, WesternU is committed to the policy of ALARA, keeping radiation doses **A**s **L**ow **A**s **R**easonably **A**chievable. This is particularly important with regard to women who are pregnant or wish to become pregnant while working with or around radioactive material.

Radiation exposure can be minimized by observing T**ime, Distance and Shielding.**

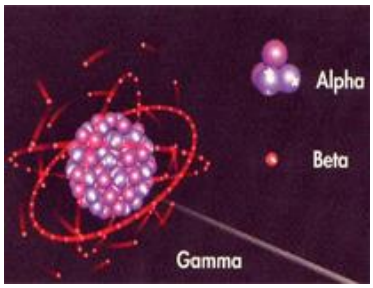
- **Time:** Dose is directly proportional to time for a constant dose rate. Therefore, reducing the time spent near the source of radiation will reduce the accumulated dose.

- **Distance:** Dose is inversely proportional to the square of the distance. Doubling the distance to the source of radiation decreases the dose by a factor of four. Using tweezers or forceps to handle radioactive material will reduce the dose.

- **Shielding:** Shielding can attenuate radiation and reduce the dose. Radioisotopes should be stored in shielded containers and, whenever practical, they should be kept behind shielding when they are in use. For gamma emitters, lead is the most common shielding material whereas for beta emitters, Plexiglas is a good choice.

BETA EMITTERS

Tritium (^{3}H) is a very low energy beta emitter with low radiotoxicity but it is also very difficult to detect without the use of liquid scintillation counting.



Carbon-14 (^{14}C) and **Sulfur-35 (^{35}S)** are low energy beta emitters with low to moderate radiotoxicity which can be detected with a Geiger Mueller (GM) instrument with a thin window. However, even the maximum beta energy from ^{14}C and ^{35}S can be stopped by 1 mm of Plexiglas and the average beta energy has a range in air of less than five centimeters.

Calcium-45 (^{45}Ca) is a moderate energy beta emitter of low to moderate radiotoxicity which can be detected with a GM instrument with a thin window. The beta range of ^{45}Ca is about twice that of ^{14}C or ^{35}S. A couple of millimeters of Plexiglas will stop the beta energy and the average range in air is less than 10 cm.

Phosphorus-32 (^{32}P) is a high energy beta emitter that needs to be carefully shielded with Plexiglas. It is highly radiotoxic if ingested because phosphorus incorporates into bone and will dose the bone marrow. **^{32}P** can penetrate up to 8 mm depth in tissue which is not enough to reach any major organs but is a skin and eye concern unless appropriate shielding is used.

Shielding high-energy beta emitters like **^{32}P** sometimes gives rise to x-rays through a process called "**bremsstrahlung**" or braking radiation. These x-rays are produced in much greater abundance with increasing beta energy and with increasing atomic number of the shield. Therefore, the best shielding materials for high-energy beta emitters are those of low atomic number like plastic with an optional outer layer of lead foil or sheet.

GAMMA EMITTERS

Chromium-51 (^{51}Cr) is a moderate energy gamma emitter that requires a substantial amount of lead shielding. It is very difficult to detect with a GM and, therefore, a portable crystal scintillation detector with a high detection efficiency for gamma rays or smear surveys used with a liquid scintillation counter, which has an even higher counting efficiency, are preferred.

Iodine-125 (^{125}I) is a low energy gamma and x-ray emitter that is very easy to shield with a thin sheet of lead. It is highly radiotoxic because it concentrates in the thyroid gland. It is best detected with a proper scintillation detector. The unbound radioactive atom is extremely hazardous with regard to inhalation and absorption through skin.

SECURITY and SIGNAGE

Access to all rooms in which radioactive material is used or stored must be restricted by card-key access. Rooms in which radioactive material is present must not be left open or unlocked unless at least one person knowledgeable about the material is in that room. Therefore, someone should

always be available to inform you of any hazards that may be present, be they radioactive, chemical, biological or physical (heat sources, etc.) in nature.

Doors to all rooms in which radioactive materials are used or stored must be labeled with a sign containing the universal symbol for radioactive material and the words "Caution, Radioactive Material". This is to inform you of the possible presence of radioactive material before you enter the room. Fume hoods, refrigerators, freezers, waste containers, bench-tops, etc. are also labeled with caution signs or yellow caution tape with the radiation symbol. ***Do not touch anything with this label without first speaking with knowledgeable laboratory personnel!***

PERSONAL PROTECTIVE EQUIPMENT

Personal Protective Equipment (PPE) prevents radioactive contamination of skin, eyes and clothing and must always be worn while handling radioactive materials. Proper eye protection, lab coat and gloves are required. Extra protection is afforded by choosing a thicker glove with longer cuffs extending over the wrists. Gloves should be placed in the proper waste container and never worn outside the laboratory. You should always make a habit of washing your hands before exiting the lab. Long pants must be worn and no open toed shoes are allowed.

LABORATORY SAFETY RULES

- Use tongs or thumb forceps when handling radioisotopes.
- Wear proper PPE.
- **Never pipette by mouth!**
- Line working surfaces with absorbent paper having an impermeable base.
- Clean up spills promptly in accordance with written instructions.
- Store and transport containers of radioactive materials on trays that will hold all of the materials if the container breaks. The trays should be covered with aluminum foil which will be discarded as solid radioactive waste after each use.
- Significant amounts of unsealed sources must be used only in well designed, exhaust ventilated enclosures such as a fume hood.
- Unless required for a volatile form, fume hoods should not be used for storage of waste containers because it impedes the air flow within the hood.
- Store all high-energy beta and all gamma emitters in properly shielded containers and enclosures.
- Placement and storage of radioactive materials must be organized and uncluttered.
- Properly label all containers.
- Monitor work areas, hands and clothing whenever there is a possibility of contamination and after each day of use.

EATING, DRINKING OR SMOKING IN ANY LABORATORY, VIVARIUM OR OTHER AREA DESIGNATED FOR THE USE OF RADIOACTIVE MATERIAL IS STRICTLY PROHIBITED! No food or beverages may be kept or consumed in areas posted for radioactive material use or storage. In addition, all other activities involving hand-to-mouth motion such as application of cosmetics, lip balm, gum chewing, etc. must be avoided. Do not place notebooks, pens, tools, etc. in posted radioactive material areas as they can easily become contaminated.

SPILLS AND ACCIDENTS

All significant incidents involving radioactive material should be immediately reported to Environmental Health and Safety (EH&S; 469-5528 or 469-8231). After hours and on weekends, call Campus Security from a land line at 469-3000 or from a cell phone at 706-3000. Give your name and the names of any other potentially affected persons, the location of the incident, the type and amount of radioactive material involved and a description of the incident.

The following incidents must be reported to EH&S immediately:

- Any incident involving possible contamination to any part of the body, including contamination of clothing that may transfer to the body.
- Any incident involving disappearance or loss of control of radioactive material, including improper disposal.
- Any incident involving known or suspected contamination of floors.
- Any incident involving radioactive contamination that cannot be immediately and completely contained and controlled.

While waiting for EH&S to respond to the scene, keep people away from the affected area and make sure that no one from the laboratory leaves until released by Radiation Safety. Remaining in the laboratory and restricting access will prevent further contamination and exposure.

FOR PERSONNEL DECONTAMINATION, refer to the Radiation Safety Manual, Section IV, Subsection N.