PREP Course 13:
Radiation Safety for Laboratory Research

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CME Disclosure Statement

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• Course Director, Kevin Tracey, has disclosed a commercial interest in Setpoint, Inc. as the cofounder, for stock and consulting support. He has resolved his conflicts by identifying a faculty member to conduct content review of this program who has no conflicts.

• William Robeson has nothing to disclose
SCOPE

- Radiation Basics
- Laboratory use of radioactive materials
- Use of irradiators
- Regulation and the Radiation Safety Committee (RSC)
RADIOACTIVITY

α

β

γ
RADIATION BASICS

- Three types (α, β, γ)
- Alpha (Rn-222)
  - Least penetrating but an ingestion/inhalation hazard
  - Not generally used in research
- Beta (P-32, H-3, S-35)
  - Frequently used in research
  - May require Lucite / Plexiglas shields
  - Measured by liquid scintillation counting
- Gamma (I-125, I-131, Cr-51)
  - Most penetrating
  - Requires lead shields
  - Measured by scintillation well counter
**TYPES OF RADIATION**

- **Alpha (α)**
  - He nucleus

- **Beta (β)**
  - Electron

- **Gamma (γ)**
  - EM radiation

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<table>
<thead>
<tr>
<th>Material</th>
<th>Alpha Protection</th>
<th>Beta Protection</th>
<th>Gamma Protection</th>
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<tbody>
<tr>
<td>Paper</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lucite / Plexiglas</td>
<td></td>
<td></td>
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<tr>
<td>Lead</td>
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</table>
EXPOSURE:
the effect of being in the vicinity of a source of radiation i.e.: sunbathing

CONTAMINATION:
the transfer of radioactive liquids or powders onto a portion of the body
RADIATION PROTECTION

- **EXPOSURE**
  - Minimize time
  - Increase distance
  - Use shielding as appropriate

- **CONTAMINATION**
  - Wear PPE (e.g., gloves, lab coats)
  - Wash hands after working with radioactivity
  - Work with volatile radionuclides in a properly vented fume hood

- **ALARA (As Low As Reasonably Achievable)**
## RADIONUCLIDES USED IN RESEARCH

<table>
<thead>
<tr>
<th>Isotope</th>
<th>Emission</th>
<th>Half-life</th>
<th>Energy</th>
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<tbody>
<tr>
<td>H-3</td>
<td>beta</td>
<td>12.3 years</td>
<td>0.0186 MeV max</td>
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<tr>
<td>C-14</td>
<td>beta</td>
<td>5730 years</td>
<td>0.156 MeV max</td>
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<tr>
<td>P-32</td>
<td>beta</td>
<td>14.3 days</td>
<td>1.71 MeV max</td>
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<tr>
<td>P-33</td>
<td>beta</td>
<td>25.3 days</td>
<td>0.248 MeV max</td>
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<tr>
<td>S-35</td>
<td>beta</td>
<td>87.2 days</td>
<td>0.168 MeV max</td>
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<tr>
<td>Cr-51</td>
<td>gamma</td>
<td>27.7 days</td>
<td>0.320 MeV</td>
</tr>
<tr>
<td>I-125</td>
<td>gamma</td>
<td>60.1 days</td>
<td>0.030 MeV</td>
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IN-HOUSE RADIOACTIVE MATERIALS PERMITS

- Specifies authorized users.
- Identify and describe locations where radioactive materials will be stored and utilized.
- Specify isotopes needed.
- Possession limits
- Training and experience (CV)
- Instrumentation (e.g., GM, beta counters, etc.)
- Approval by Radiation Safety Committee
ORDERING RADIOACTIVE MATERIALS

- Requires a radioactive materials permit
- Activity requested must not exceed possession limit
- Orders are placed by RSO
- All radioactive materials are received by the RSO and checked prior to distribution to the users.
STORAGE

- **Security**
  - Secure isotope source vials when not in use

- **Radiation protection**
  - Use appropriate shielding

- **Refrigerator / Freezer units**
  - No food or beverages
  - Warning Label
RECORDKEEPING

- Copy of current permit
- Inventory
- Survey and wipe test results
- Waste disposal logs
**RADIOACTIVE MATERIALS INVENTORY FORMS**

**LABORATORY:** Immunology  Lot #: A-1111  
**Isotope:** P-32  **Chemical Form:** dCTP  
**Date Received:** 3/1/09  **Act:** 250 uCi  **Vol:** 25 ul

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<tr>
<th>Date</th>
<th>Amount Used</th>
<th>Balance</th>
<th>Initials</th>
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<tr>
<td>3/3/09</td>
<td>5 ul</td>
<td>20 ul</td>
<td>JS</td>
</tr>
<tr>
<td>3/5/09</td>
<td>10 ul</td>
<td>10 ul</td>
<td>JS</td>
</tr>
<tr>
<td>3/6/09</td>
<td>5 ul</td>
<td>5 ul</td>
<td>MB</td>
</tr>
<tr>
<td>3/7/09</td>
<td>3 ul</td>
<td>2 ul</td>
<td>MB</td>
</tr>
<tr>
<td>4/1/09</td>
<td>Discarded to Radiation Safety</td>
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AREA SURVEYS

- GM Pancake meter
- Use to detect radiation and locate contamination (e.g., bench top, hands, feet, lab coats, etc.)
LABORATORY SURVEYS REQUIRE A SKETCH

Area 1: Background

- Workbench
- Sink
- Refrigerator
- Centrifuge
- Desk
- Telephone
- Floor
- Hood

4 5 6
3
2
11
9 10
12
Threshold for positive wipe test = 2x background
DPM = (CPM - BKG) / EFF
Efficiencies supplied by Radiation Safety Office
COUNTER EFFICIENCIES

**Beta Counter**

<p>| | | |</p>
<table>
<thead>
<tr>
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<tbody>
<tr>
<td>H-3</td>
<td>0.55</td>
<td>55 % eff.</td>
</tr>
<tr>
<td>Others</td>
<td>0.90</td>
<td>90 % eff.</td>
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</table>

**Gamma Counter**

<p>| | | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
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</thead>
<tbody>
<tr>
<td>I-125</td>
<td>0.70</td>
<td>70% eff.</td>
</tr>
<tr>
<td>I-131</td>
<td>0.35</td>
<td>35% eff.</td>
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SPILL PROCEDURES

- DON’T PANIC
- Inform co-workers
- Prevent the spread
- Clean up outside-in
- Survey
- Report to RSO
PERSONNEL DECONTAMINATION

- DON’T PANIC – ask for assistance
- Remove contaminated clothing
  - why we wear lab coats
- Flush thoroughly if spill on skin
- Wash with mild soap and lukewarm water
- Do not use abrasive brushes (forget Silkwood)
- Have scrubs and shoe covers available
- RSO will make recommendations concerning contaminated clothing (i.e., decay to background)
CENTRALIZED RADIOACTIVE WASTE DISPOSAL

- Radioactive waste must be held for a minimum of 10 half-lives prior to disposing as non-radioactive. 
  (H-3 or C-14 excluded)

- Waste must be segregated by isotope (half-life)

- Waste must be segregated by type (liquid, solid)
RSO LABORATORY INSPECTION

- Visual laboratory inspection
  - work areas neat and lined with absorbent liners
  - radioactive materials stored and properly secured
  - waste not overflowing, properly segregated and shielded
  - gloves and lab coats in use
  - no food / drinks in the lab

- Records

- Not punitive but instructive
Source: Cs-137

Half-Life: 30.17 years

Activity: 631 Ci on 6/29/83

Average Dose Rate: 2.40 Gy/min (Jan-2013)

CV = 8.2%

Primary Use: cells

Requires fingerprinting for FBI security clearance
IRRADIATION CHAMBER
X-Ray IRRADIATOR

- RS 2000 Biological Irradiator by Rad Source
- Advantages: Multiple animal irradiation simultaneously
- Uniform dose delivery
- Easy to operate
ANIMAL RESEARCH

- Needs IACUC approval
  - X-ray irradiator
  - Cs-137 irradiator
  - Radioactive materials

- Consult with Radiation Safety Office prior to protocol submission
RADIATION SAFETY COMMITTEE (RSC)

- Authorized under NYSDOH broad scope license
- Establishes institutional RM policies and procedures
- Issues in-house RM permits
- The Radiation Safety Manual is available on Healthport: Policies – NSUH- Manhasset
- Contact Information:
  - Radiation Safety Office: FIMR Room 3155 (516) 562 - 3895