

# CARBON - 14

## [<sup>14</sup>C]

### PHYSICAL DATA

- Beta Energy: 156 keV (maximum)  
49 keV (average) (100% abundance)
- Physical Half-Life: 5730 years
- Biological Half-Life: 12 days
- Effective Half-Life: 12 days (bound)
- Effective Half-Life: 40 days (unbound)
- Specific Activity: 4460 mCi/gram
- Maximum Beta Range in Air: 24.00 cm = 10 inches
- Maximum Beta Range in Water/Tissue: \*0.28 mm = 0.012 inches
- Maximum Range in Plexiglas/Lucite/Plastic: 0.25 mm = 0.010 inches

\*Fraction of <sup>14</sup>C beta particles transmitted through dead layer of skin: At 0.007 cm depth = 1%

### RADIOLOGICAL DATA

- Critical Organ: Fat Tissue
- Routes of Intake: Ingestion, Inhalation, Skin Contact
- External exposure: Deep dose from weak <sup>14</sup>C beta particles is not a radiological concern
- Internal exposure & contamination: Primary radiological concerns
- Committed Dose Equivalent (CDE): 2.08 mrem/uCi (ingested)  
(Fat Tissue) 2.07 mrem/uCi (puncture)  
2.09 mrem/uCi (inhalation)
- Committed Effective Dose Equivalent (CEDE): 1.54 mrem/uCi (ingested)
- Annual Limit on Intake (ALI)\*: 2 mCi (ingestion of labeled organic compound)  
2000 mCi (inhalation of carbon monoxide)  
200 mCi (inhalation of carbon dioxide)

\*[1.0 ALI = 2 mCi (ingested C- 14 organic compound) = 5,000 mrem CEDE]

- Skin Contamination Dose Rate: 1090-1180 mrem per 1.0 uCi/cm<sup>2</sup> (7 mg/cm<sup>2</sup> depth)
- Dose Rate to Basal Cells from Skin Contamination, 1.0 uCi/cm<sup>2</sup> = 1400 mrad/hour.
- Immersion in <sup>14</sup>C Contaminated Air = 2.183E<sup>7</sup> mrem/year per uCi/cm<sup>3</sup> at 70 um depth of tissue and 4.07E<sup>6</sup> mrem/year per uCi/cm<sup>3</sup> value averaged over dermis.

### SHIELDING

- None required (≤ 3 mm Plexiglas)

### SURVEY INSTRUMENTATION

- Can detect <sup>14</sup>C using a thin-window G-M survey meter; survey meter probe **must** be at close range (1 cm.)
- G-M survey meters have very low counting efficiency for <sup>14</sup>C (5%).
- Liquid scintillation counter (indirect counting) may be used to detect removable <sup>14</sup>C on wipes.

## RADIATION MONITORING DOSIMETERS

- Not needed (beta energy too low).
- $^{14}\text{C}$  Beta Dose Rate: 6.32 rad/hr at 1.0 cm. in air per 1.0 mCi  $^{14}\text{C}$
- Skin Contamination Dose Rate: 13.33 mrad/hr per uCi on skin
- Dose Rate from a 1 mCi isotropic point source of  $^{14}\text{C}$ :

<u>Distance</u>	<u>Rad/Hr</u>
1.0 cm	1241.4
2.0 cm	250.4
15.2 cm	0.126
20.0 cm	0.0046

## GENERAL RADIOLOGICAL SAFETY INFORMATION

- Urinalysis: Not Required; however, prudent after a  $^{14}\text{C}$  radioactive spill or suspected intake.
- Inherent volatility (at STP): Not Significant.
- Possibility of organic  $^{14}\text{C}$  compounds being absorbed through gloves.
- Care should be taken NOT to generate  $^{14}\text{CO}_2$  gas which could be inhaled.
- Internal Dose is the concern: Skin contamination, ingestion, inhalation, and puncture.
- Always wear a lab coat and disposable gloves when working with  $^{14}\text{C}$ .
- The concentration of carbon in adipose tissue, including the yellow marrow, is about 3 times the average whole body concentration. No other organ or tissue of the body concentrates stable carbon to any significant extent.
- The fractional absorption of dietary carbon (uptake to blood) is usually in excess of 0.90.
- Three main classes of carbon compounds may be inhaled: organic compounds, gases ( $\text{CO}$  or  $\text{CO}_2$ ), and aerosols of carbon containing compounds such as carbonates and carbides.

**Organic Compounds** - most organic compounds are NOT very volatile under normal circumstances; the probability of these being inhaled as vapors is therefore small. In circumstances where such substances are inhaled, it would be prudent to assume that once they enter the respiratory system they are instantaneously and completely translocated to the systemic circulation without changing their chemical form.

**Gases** - the inhalation of  $\text{CO}$  and its retention in body tissues has been studied extensively. Since gas has a relatively low solubility in tissue water, doses due to absorbed gas in tissues are insignificant in comparison with doses due to the retention of  $\text{CO}$  bound to hemoglobin.  $\text{CO}_2$  in the blood exists mainly as a bicarbonate.

**Carbonates & Carbides** - It is assumed that inhaled or ingested  $^{14}\text{C}$  labeled compounds are instantaneously and uniformly distributed throughout all organs & tissues of the body where they are retained with a biological half-life of 12-40 days.