

22.01 Introduction to Ionizing Radiation  
Fall 2003  
Professor Coderre  
Quiz # 3  
November 26, 2003

Name: \_\_\_\_\_

You have 50 minutes to complete this quiz.  
This quiz is closed book.  
Please show all work on the attached sheets.

This quiz consists of 7 questions worth a total of 100 points.

The point values for each question are indicated in parentheses next to the question number.

1. (15 points)

“Radiation doses above 12 Sv are invariably fatal.”

“Radiotherapy for cancer treatment typically delivers doses of 17-65 Gy to normal tissues with little to no chance of dying from the radiation.”

These statements are both true. Is this a contradiction? Discuss.

2. (15 points)

An accident has occurred in a uranium fuel processing plant and 3 workers are exposed to significant radiation dose. Worker A receives whole body absorbed doses of 3 Gy of 2 MeV neutrons ( $w_R = 10$ ) and 5 Gy of 1 MeV photons. Worker B receives a whole body absorbed dose of 8.0 Gy photons and Worker C receives a whole body absorbed dose of 1 Gy from 1.0 MeV photons. All three workers are hospitalized.

- (a) What symptoms do you expect to observe, and when, in each worker?
- (b) What can you say about the likelihood of death for each worker and what is the mechanism of death?
- (c) What type of medical care should each worker receive?

3. (15 points)

Consider two cell survival curves. Curve 1 has a  $D_0$  of 0.3 Gy and an extrapolation number,  $n$ , of 1.0. Curve 2 has a  $D_0$  of 3.1 Gy and an extrapolation number,  $n$ , of 10.0.

- a) Which curve is the high-LET radiation dose response?
- b) What is the RBE?
- c) What would happen to the  $D_0$  values for each of these curves (i.e., would they get larger, smaller or stay the same) if the total radiation dose was delivered in 5 fractions, each 2 hours apart?

4. (10 points)

- a) Discuss the distinction between **dose**, **equivalent dose**, and **effective dose**.
- b) What are their units?
- c) Why is it important to make these distinctions?
- d) How is LET incorporated into these definitions?

5. (15 points)

A person puts a radioactive source in his pocket by accident. A 10 cm diameter area of skin on the thigh receives a dose of 25 Gy in 1 hour before the source is discovered and removed.

Describe the sequence of events that is expected in the exposed area. Be thorough; describe the cell types involved, the time of occurrence of the effects and the ultimate outcome.

6. (15 points)

Standard fractionated radiation therapy, using 25 MeV photons, is given as follows: 2 Gy per fraction, 1 fraction per day, 5 days per week, for 6 weeks, for a total tumor dose of 60 Gy.

An experimental clinical trial is evaluating the following schedule: 1.4 Gy per fraction, 3 fractions per day, 12 days in a row, for a total dose of 50.4 Gy.

- a) What would be the advantage of this accelerated treatment?
- b) What could be a potential disadvantage?

7. (15 points)

Two people accidentally drink radioactive solutions.

Person A drinks water containing 1 millicurie of tritium, as tritiated water.

Person B drinks a water solution containing 1 millicurie of radium.

$^3\text{H}$ , half-life = 12 years, beta energy = 18 keV

$^{226}\text{Ra}$ , half-life = 1600 years, alpha energy = 4.7 MeV

- a) What will be the biological fate of the radioactivity?
- b) What health effects are these people likely to face over the rest of their lifetimes?
- c) What steps could these people take to remove the activity from their bodies and reduce the exposure?