22.55 Spring 2004
Professor Coderre
February 25, 2004
Due: March 3, 2004

Problem Set 3

1. Given the following cell data:

X rays		α-particles	
Dose (cGy)	Surviving fraction (%)	Dose (cGy)	Surviving fraction (%)
0	100	0	100
330	60	100	45
620	28	200	15
826	12	400	2.5
1239	1.7	600	0.45
1653	0.11	800	0.06
2479	0.0009	1200	0.0015

   a. Estimate the RBE of the α-particles relative to the x-rays. Explain how you determined the RBE.
   b. Estimate the D_0 value for the alpha particles and the x-rays.
   c. What is the extrapolation number, n, for the x-rays?
   d. Is the RBE higher or lower at 10% survival than at 1% survival? Give an explanation for this.

2. Below are some survival curve data for V79 cells in tissue culture exposed to X-rays under aerated and hypoxic conditions.
   (a) Plot the cell survival curves.
   (b) Calculate the values of D_0, D_q and n.
   (c) Calculate the α and β parameters from a linear quadratic fit for each set.

Aerobic		Hypoxic	
Dose (Gy)	Surviving Fraction	Dose (Gy)	Surviving Fraction
4	0.5	15	0.42
8	0.18	27	0.11
12	0.027	39	0.017
16	0.0042	54	0.0025
20	0.00067	63	0.00045

3. Given the following cell survival data:

Dose (cGy)	# Cells Plated	# Colonies Observed
0	200	30
200	800	108
400	1000	105
600	1000	75
800	1500	67
1000	3000	81
1300	3000	27
1600	40,000	90
2000	100,000	60

a. What is the plating efficiency?
b. What is D_0?
c. What is the extrapolation number, n?

Getting to Know SRIM
[Stopping and Range of Ions in Matter]

Go to: http://www.srim.org/, Download the program SRIM 2003
SRIM has 2 components
1. Stopping/Range Tables, which will provide –dE/dx and residual range as a function of energy.
Any ion can be projected into any **homogeneous** target. Targets can be complex mixtures of elements, but not multiple layers of different composition. Any ion energy from very low (eV) up to 2 GeV/amu (ouch!) can be used.
2. TRIM Calculation, which graphically projects the particles into complex targets. TRIM will accept layered targets.
Explore the different menus. Look at the demos in the TRIM calculation.

Problems:

SRIM 1. Use the Stopping/Range Tables program to project 7.0 MeV alpha particles into liquid water. You will have to enter a lower limit on the energy as well. Pick something reasonable. Print the output. Graph LET vs energy. Graph range vs energy.

SRIM 2. Use SRIM to calculate the stopping power and range values in water for 30.5 MeV alpha particles and 1.2 MeV protons. How do the SRIM values compare to the values you calculated by hand in Problem Set 1?