UNIVERSITY COLLEGE LONDON

University of London

EXAMINATION FOR INTERNAL STUDENTS

For The Following Qualification:-

M.Sc.

M.Sc. Radiation Biology: Paper 1

COURSE CODE	:	**RDBL0001**
DATE	:	**28-APR-05**
TIME	:	**10.00**
TIME ALLOWED	:	**3 Hours**

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Please use a SEPARATE ANSWER BOOK for EACH QUESTION

Standard electronic calculators may by used.

Answer ONE question from EACH of the FOUR sections.

Section 1:

1. A beam of 1 MeV photons enters a block of soft tissue. Describe the most likely interaction that will take place. Sketch the secondary electron spectrum that would be the result of this interaction.

   A beam of 1 MeV charged particles was passed through different thicknesses of a material and a suitable detector counted the number that were transmitted per second. The following data are obtained.

Thickness (cm)	Counts	Thickness (cm)	Counts	Thickness (cm)	Counts	Thickness (cm)	Counts
0	100	1.2	95	1.8	45	2.4	4
0.2	99	1.3	96	1.9	35	2.5	3
0.4	100	1.4	93	2.0	28	2.6	2
0.6	97	1.5	89	2.1	18	2.7	1
0.8	96	1.6	70	2.2	10	2.8	0
1.0	97	1.7	60	2.3	5	2.9	0

   Plot these results and from the graph estimate the *mean range* and the *extrapolated range*. What type of charged particle would exhibit the behaviour shown in the graph? Give reasons for your answer.

   What energy would you expect the charged particles to have that leave the material after travelling through a thickness of 1.5 cm? If the beam were 1 MeV photons what energy would they have after travelling through a thickness of 1.5 cm?

2. Discuss the two main assumptions of Bragg-Gray Cavity theory and outline how these assumptions allow the measurement of dose in a material.

   Describe the principle of operation of an ionisation chamber.

   A radioactive source has an activity of 10 GBq and emits gamma rays with energy of 2 MeV.

   (a) Calculate the exposure at a distance of 5 cm from the source;

   (b) A water bath is placed 10 cm beneath the source. Calculate the collision kerma at (i) the surface of the water bath, and (ii) at a depth of 2 cm in the water bath.

   (c) Sketch the variation of both collision kerma and absorbed dose with depth into the water.

($W_{air}/e = 33.97\ J\,C^{-1}$; mass energy absorption coefficient for air at 2 MeV $= 2.35 \times 10^{-2}\ cm^2\,g^{-1}$ and for water at 2 MeV $= 2.6 \times 10^{-2}\ cm^2\,g^{-1}$; linear attenuation coefficient for water at 2 MeV $= 4.94 \times 10^{-2}\ cm^{-1}$)

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Section 2:

3. Describe and illustrate the two main mechanisms for the repair of DNA double strand breaks and their normal role in cell physiology.

4. Compare the formation of dicentric chromosomes and translocations in irradiated lymphocytes. Why are translocations more stable than dicentrics? Fluorescence *in situ* hybridisation (FISH) is suitable for detecting translocations in human metaphase preparations. Describe the principle of FISH and its practical applications. Which method would you use to estimate the radiation exposure of a person after an accident after 1 week? after 1 year? after 10 years?. How have the stability of chromosome aberrations in radiation accident victims been investigated and what were the findings?

Section 3:

5. In 1933, A. Reisner published an extensive experiment on the effects of dose fractionation on acute radiodermatitis in patients after irradiation of normal skin to 2 x 2 cm fields with 75 kV X-rays. The following table lists the results of one of those experiments giving isoeffective doses given daily. Estimate the alpha-beta ratio from these data by the graphical method. Derive the equation underlying the graphical method from the normal linear quadratic dose response curve.

Number of fractions	Isoeffective dose [Gy]
1	10
2	13
3	15
4	17
7	21
12	27

6. When intensive treatment regimens are used for squamous cell carcinoma of the head & neck region early mucous membrane reactions (radiation mucositis) are dose limiting. Describe the pathogenesis. What is the characteristic latent period for the development of confluent mucositis after conventional fractionation schedules and what is the expected effect of delivering the same total dose in a shorter overall treatment time on the incidence and severity of mucositis in a group of patients. What are the consequential late effects and describe their pathogenesis?

Section 4:

7. Describe three epidemiological studies which determined the risk of breast cancer after radiation exposure of the breast, also giving range of doses and ages. Describe the relationship of radiation risk to the breast on age at exposure.

8. Describe the seven locus method of genetic experiments in mice. Why does the doubling dose determined by the seven locus method overestimate the true genetic risk and how is this problem resolved in the risk equation by a correction factor? Estimate the risk to the child of a person exposed to 0.5 Gy to develop a heritable disease with recessive inheritance and a multifactorial heritable disease and explain the various factors you use in this estimation.

END OF PAPER