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	:	**01-MAY-03**
TIME	:	**10.00**
TIME ALLOWED	:	**3 Hours**

03-N0239-3-30

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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. What interactions could take place between a photon and matter over the energy range of 10 keV and 10 MeV? Sketch a graph that demonstrates which of the interactions is dominant over given regions of energy and atomic number.

   Select one of these interactions and give a description of the interaction, its consequences, and its dependence upon the physical parameters of the interaction.

   A narrow beam of 10^6 2.0 MeV photons enters a 10 x 10 x 10 cm cube of soft tissue at the centre of, and perpendicular to, one face. A detector (10 x 10 cm) is held close to the opposite face and is used to measure the energy of each photon that leaves. Use the data in the table below to estimate the total linear narrow beam attenuation coefficient and the total linear broad beam attenuation coefficient.

Energy of photons that leave (MeV)	2.0	1.0 – 2.0	0.5 – 1.0	0.01 – 0.05
No. of photons with that energy	611292	122436	67678	69954

2. Define the term *percentage depth dose.*

   Sketch the percentage depth dose curve for a 12 MV X-ray beam incident on a slab of soft tissue. Explain the shape of the curve.

   A caesium-137 source with an activity of 5×10^6 Bq is placed at a distance of 10 cm from the surface of a large water bath. An air-filled dosimeter with a diameter of 1 cm is used to measure the dose.
   The dosimeter is placed at the surface of the water bath (*assume backscatter effects are negligible*):
   a) Calculate the energy fluence at the dosimeter in J cm^{-2}.
   b) Calculate the dose rate at the dosimeter (assume charged particle equilibrium exists).
   The dosimeter is now placed at a depth of 3 cm in the water bath (*1 cm of water attenuates 10% of the beam at this energy*)
   c) Calculate the dose rate at the dosimeter at this depth.
   d) The air in the dosimeter is replaced by water. What total dose does the dosimeter now record in 1 minute?

   (Caesium-137 emits gamma rays with an energy of 662 keV; 1 Bq is equivalent to 1 gamma-ray emission per second; 1 eV = 1.602×10^{-19} J; μ_{en}/ρ for air = 29.5 cm^2/kg; μ_{en}/ρ for water = 32.5 cm^2/kg)

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Section 2:

3. What are radiation sensitive syndromes? Describe three examples and how their study increased the understanding of repair of different types of DNA damage.

4. a) Sketch an example of a shouldered cell survival curve which would be obtained by irradiating mammalian cells with X-rays. Describe how you would analyse the curve using 1) the linear quadratic model and 2) the multi-target model and the important parameters you would obtain for each model.

   b) An experiment was performed where cells *in vitro* were irradiated with a split dose of 2 x 6 Gy given at 2 hours, 6 hours and 12 hours apart with incubation at 37°C between the doses. Describe how survival would change under these conditions and outline the cellular processes responsible for these changes.

Section 3:

5. Consider the following observation: the TCD50 of a small squamous cell carcinoma (T2) with fractionated radiotherapy is 56 Gy, the TCD50 of the same tumour type with a volume ten times bigger is 63 Gy. Estimate, from these clinical data, the approximate surviving fraction after 56 Gy. Assuming the loss of radiation effect due to repopulation is 14 Gy, estimate the number of tumour stem cells in the small squamous cell carcinoma. Explain the assumptions you are making in these calculations.

6. Accelerated repopulation is a characteristic feature of the response of normal and malignant squamous epithelia to fractionated irradiation. Describe the methods to investigate the kinetics of accelerated repopulation and the results of these experiments in oral mucosa. Explain the cellular mechanisms contributing to the accelerated repopulation in oral mucosa (the "three A's").

Section 4:

7. After the Chernobyl accident, the major health consequences were caused by the uptake of radioiodines by very young children. Describe the radioecological processes leading to exposure of young children. Why are very young children much more sensitive to radioiodine-induced thyroid cancer than adults?

8. Describe the epidemiological design of the case control studies to investigate the lung cancer risk from radon in homes. How are cases and controls selected, how is exposure determined, how is risk calculated? Describe the results of those studies with particular emphasis of the interaction of radon exposure and cigarette smoking.

END OF PAPER