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	:	**04-MAY-04**
TIME	:	**14.30**
TIME ALLOWED	:	**3 Hours**

04-N0209-3-30

TURN OVER

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. Photons and charged particles interact differently when they pass through a material. Discuss why these different mechanisms occur and describe the important differences in the resultant outcomes.

Draw typical tracks that a heavy charged particle and an electron might take on entering a material. Indicate on your diagram the *pathlength* and *average depth of penetration* for both the heavy charged particle and the electron. Use these diagrams to discuss how the *mean range* might be related to the parameters marked on your diagrams.

The Bethe formula for the mass stopping power of a charged particle is:

$$\frac{1}{\rho}\left(\frac{dT}{dx}\right) = \frac{4\pi r_e^2 mc^2}{\beta^2}\frac{1}{u}\frac{Z}{A}z^2\left[ln\left(\frac{2mc^2\beta^2\gamma^2}{I}\right) - \beta^2\right]$$

Assuming that the quantity in square brackets can be regarded as a constant, if the mass stopping power of a 1 MeV proton in water is 268 MeV cm^2 g^{-1} determine the approximate mass stopping power in water of an α-particle at the same energy.

2. Draw a labelled diagram of the principal components of a diagnostic X-ray tube.

Sketch the X-ray spectrum that would be obtained from a tungsten target X-ray tube operated at a tube potential of 80 kV (*K-edge of tungsten is 69 keV*).
State briefly the various factors that give the spectrum its shape. Note any important energy values.

Define the terms kerma, exposure and absorbed dose, and state the units of each.

Consider a sample of Tc-99m with an activity of 3 MBq, which emits gamma rays equally in all directions.

(i) Calculate the fluence rate at a distance of 50 cm.
(ii) How long does it take for the source activity to drop to 0.5 MBq?
(iii) Calculate the total exposure in 1 minute at a distance of 50 cm.
(iv) Calculate the absorbed dose rate to soft tissue. State any assumptions you have made.

(1 Bq is equivalent to 1 gamma-ray emission per second; 1 eV = $1.602x10^{-19}$J; Tc-99m emits gamma rays with energy of 140 keV and has a half life of 6 hours; W_{air}/e = 33.97 J C^{-1}; mass energy absorption coefficient at 140 keV of air = 25 cm^2 kg^{-1} and of soft tissue = 27.5 cm^2 kg^{-1})

TURN OVER

Section 2:

3. List the basic features of the three major groups of tandemly repetitive sequences in eukaryotic DNA. Outline the technique used to detect ESTR mutations in mouse cells. Describe the advantages and disadvantages of the analysis of mutations in repeat sequences as a marker for radiation exposure.

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

Section 3:

5. Describe mechanisms and the potential use of gene therapy in combination with radiotherapy in cancer treatment.

6. Contrast the differences between acute and chronic normal tissue injury after radiotherapy with regard to principal symptoms, pathological features, latency, time course, dose dependence, fractionation sensitivity (α/β), time factor and pathogenetic mechanisms.

Section 4:

7. Describe the epidemiological design of the Life Span Study of the Japanese A-bomb survivors. How were the individual radiation doses determined in the presently used dosimetric system (DS86). Discuss the neutron doses in the Hiroshima survivors and methods to estimate their size and impact for radiation risk.

8. Mammography screening for breast cancer has been recommended only for women over 50. Explain the reasons for this critically considering the age dependences of prevalence, detectability, curability, radiation risk.

END OF PAPER