UNIVERSITY COLLEGE LONDON

University of London

EXAMINATION FOR INTERNAL STUDENTS

For The Following Qualification:-

M.Sc.

M.Sc. Radiation Biology: Paper 2

COURSE CODE	:	**RDBL0002**
DATE	:	**05-MAY-04**
TIME	:	**14.30**
TIME ALLOWED	:	**3 Hours**

04-N0210-3-30

TURN OVER

Please use a SEPARATE ANSWER BOOK for EACH QUESTION

Standard electronic calculators may by used.

Answer FIVE questions

1. 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.

   Show how the curve would change if the soft tissue is replaced by a more dense material, such as bone tissue. Give reasons.

   Sketch the variation of kerma with depth through the soft tissue for the same incident X-ray beam.

   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 in air 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 in air at the dosimeter at this depth.
   d) What would be the total dose to water in one minute at this depth.

   (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)

2. Describe the design of an experiment to investigate the initial frequencies of chromosome aberrations (i.e. breaks, dicentrics and translocations) and their repair kinetics in human peripheral blood lymphocytes exposed to 3 Gy X-rays using the premature chromosome condensation (PCC) method. Your answer should include a diagram of the PCC technique and a comparison of PCC with the conventional metaphase preparation.

3. Explain the term "radiation-induced genomic instability". Describe the experimental methods to study the dose and time dependence of radiation-induced genomic instability. Describe the arguments put forward that this phenomenon may play a key role in radiation carcinogenesis.

TURN OVER

4. A radiotherapy department plans to introduce hyperfractionation for the treatment of advanced squamous cell carcinomas of the head and neck changing from giving 35 fractions of 2 Gy each to 2 fractions of 1.2 Gy per day without increasing overall treatment time and without increasing the risk of chronic normal tissue damage. Use the BED equation to calculate the dose that can be given and estimate the potential increase in local tumour control rate. Explain how the BED equation is related to the linear quadratic cell survival curve equation and state the other assumptions you are making in your calculation.

5. It is often claimed that tumour recurrences after curative radiotherapy are due to the development or selection of radioresistant mutants in a similar way as in chemotherapy. How can you test this hypothesis. What are the results of this type of experiment?

6. Describe the cellular basis of acute radiation damage to haemopoietic tissues. In your answer, include a description of the specific radiation effects on a) stem cells, b) transit cells, c) differentiating cells and d) functional cells and their consequences for haemopoiesis. State the effects of growth factors in the irradiated bone marrow.

7. The genetic risk is estimated using the equation:

   Risk=prevalence (P) x 1/doubling dose (DD) x mutational component (MC) x potential recoverability correction factor (PRCF)

   Describe these 4 parameters estimating the risk of dominant single gene disorders, of recessive single gene disorders and of multifactorial diseases after a gonadal exposure of 1 Gy.

8. Describe the 3 different types of epidemiological studies (cohort, case-control, geographic) which have been used in radioepidemiological research with reference to the different types of question they address. Give one example for each design.

END OF PAPER