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	:	**27-APR-06**
TIME	:	**14.30**
TIME ALLOWED	:	**3 Hours**

06-N0181-3-30

TURN OVER

Please use a SEPARATE ANSWER BOOK for EACH QUESTION

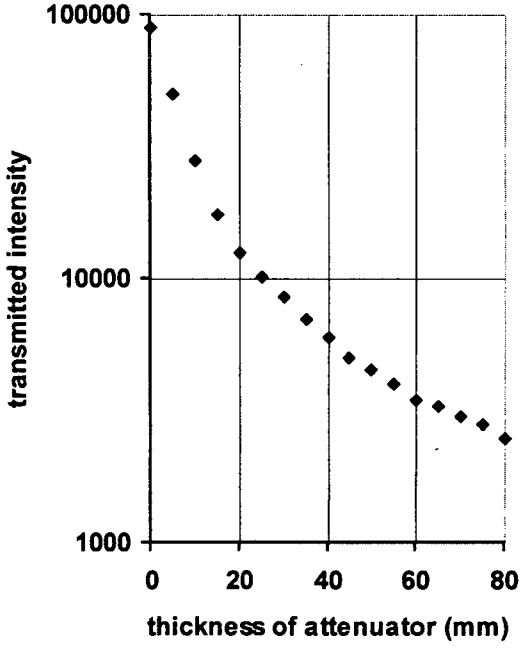
Standard electronic calculators may be used.

Answer ONE question from EACH of the FOUR sections.

Section 1:

1. Draw typical tracks that a heavy charged particle and an electron might take on entering a material. Indicate on your diagram the *pathlength* and explain how the stopping power can be calculated. Describe, using diagrams, *linear energy transfer* and explain how *LET* would change if the energy of the incoming particles increased.

In an experiment to measure the attenuation of a photon beam the following result is found;



Discuss in detail the experimental arrangement that would have been used and make qualitative conclusions about the beam and its interactions that could lead to the above result.

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	0.01-0.5
No. of photons with that energy	611,292	122,436	67,678	69,954

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2 (a) Explain the meaning of the term Kerma. How does it differ from the collision Kerma? Under what circumstances is the value of absorbed dose equal to the collision Kerma? Explain why.

(b) Cs-137 is a radioactive isotope that decays by beta decay to Ba-137m (a metastable state of Ba-137). Ba-137m then decays qucikly to Ba-137 emitting gamma rays. Barium has an atomic number 1 greater than caesium. Describe this process of beta decay and the subsequent decay to Ba-137. What is meant by the term *metastable*?

(c) An ionisation chamber filled with air is used to measure dose. It is placed at a depth of 3 cm in a water bath and irradiated with a Cs-137 source at a distance of 50 cm from the surface of the water bath. The chamber measures an exposure of 0.5 Ckg^{-1} in 30 seconds. Calculate:

i) the absorbed dose rate in the water immediately surrounding the chamber,
ii) The photon fluence at the chamber surface,
iii) The activity of the source (assuming that 1 cm of water attenuates 10% of the photon beam, ignore the effects of scatter).

(Caesium-137 emits gamma rays with an energy of 662 keV; W/e = 33.85 J C^{-1} for air, 1 eV = 1.602×10^{-19} J; μ_{en}/ρ for air = 28.9 cm^2/kg; μ_{en}/ρ for water = 32.5 cm^2/kg)

Section 2:

3. Outline the principles of the comet assay and describe how you would use this assay to measure DNA double-strand breaks (dsb) in irradiated cells. Describe the molecular basis for the use of phosphorylated H2AX as a marker for DNA dsb and discuss the advantages and disadvantages of this marker relative to the comet assay.

4. 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 multistage model of carcinogenesis. Discuss the possible role of radiation-induced genomic instability in radiation carcinogenesis.

Section 3:

5. Describe the pathogenesis of radiation mucositis. What is the characteristic latent period for the development of confluent mucositis after conventional fractionation schedules. What is the expected effect of accelerating the same total dose in a shorter overall treatment time on the incidence and severity of mucositis in a group of patients. What role is played by cytokines in the radiation response of the oral mucosa and discuss the potential therapeutic role of cytokines for the treatment and prevention of oral mucositis.

TURN OVER

6. What is the evidence that cure of cancer by radiotherapy requires the sterilisation of even the last clonogenic tumour (stem) cell? Describe the relationship between exponential cell kill and probability of local tumour control. If one tumour is 10 times the volume of another, estimate the extra radiation dose required to achieve equal probability of cure for the larger tumour. Describe the experimental design to test whether local recurrences after radiotherapy are the result of selection of radioresistant subpopulations in the same way as regrowth during chemotherapy. What is the result of this experiment?

Section 4:

7. How are genetic diseases in humans classified and what are the current estimates of their incidence? Explain the concepts of mutation component and potential recoverability correction factor and how the mutation component affects the estimation of genetic risks after irradiation for each of the different classes of heritable disease. Which class of heritable disease contributes most to the overall genetic risk in the children of irradiated parents?

8. Why are the epidemiological studies performed in the populations living along the Techa river considered to be potentially the most important studies besides the Japanese atom bomb survivor studies for radiation-risk estimation? Describe exposure scenario, methods used to estimate individual radiation doses and the presently available risk estimates from the Techa river population.

END OF PAPER