

CMPI Examination Paper II Question Bank  
Specialty: Radiation Biology & Radiation Safety

(Revised June 2014)

*Question bank for section II*

*It is not guaranteed that the questions for the CMPI exam will be from this bank alone.*

Section I: Multiple choice questions (No question bank will be available for this section)

Section II: Definitions / Short answers

1. What is Direct action?
2. What is indirect action?
3. What is the dominant process for biologic damage of cells by x-rays?
4. Why Radio protective compounds are not useful for Neutrons and alpha particles?
5. What are the types of DNA damage?
6. What is defined as double strand break?
7. What is chromosome aberration?
8. What is Chromatid aberration?
9. What is the lowest single dose that can be detected by scoring aberrations in lymphocytes of irradiated humans?
10. What are dicentrics?
11. What are free radicals?
12. What are Translocations?
13. What is a cell survival curve?
14. What is  $\alpha/\beta$ ? What is its' unit?
15. What are the phases of cell cycle?
16. Which phases of cell cycle the cells are more radiosensitive and radio resistant?
17. What is potentially lethal damage?
18. Define Sub-lethal damage.
19. Define Oxygen Enhancement Ratio (OER)
20. What is hypoxia and what are the types?

21. What is Linear Energy Transfer (LET)?
22. What is the special unit of LET?
23. What is Relative Biologic Effectiveness (RBE)?
24. What is inverse dose rate effect?
25. What is LD<sub>50</sub> ?
26. What are the symptoms of supra-lethal exposure?
27. What are radioprotectors? and what is the mechanism by which the radioprotectors act?
28. Define Stochastic effect of radiation and give example
29. Define deterministic effect of radiation and give example
30. What is latent period?
31. What is the average latency for leukemia and for solid tumors?
32. What are the threshold for temporary sterility and permanent sterility in male?
33. What dose to the embryo and at which period of gestation would be regarded as the cut off point to consider an abortion?
34. What are the principle effects of radiation on developing embryo and fetus?
35. What are the minimum doses required for inducing cataract in single exposure and in a protracted exposure?
36. What is Growth fraction ? write down its expression.
37. What is cell-loss factor ( $\phi$ )?
38. What is the equation of total dose derived from the strandquist plot?
39. What is the effect of prolonging overall time within the normal radiotherapy?
40. What is therapeutic ratio?
41. Define Hyper-fractionation in Radiotherapy?
42. What is hypo-fractionation?
43. What does CHART refer to in Radiotherapy fractionation? And what are its influences on early and late effects?
44. What is biologic effective dose (BED) and how is that calculated?
45. What is radiation weighting factor?
46. What is tissue weighting factor/
47. What is Equivalent dose?
48. What is inverse dose rate effect?
49. What is committed equivalent dose?
50. What is genetically significant dose?
51. Define Body Burden
52. Define Primary Barrier,
53. Define Secondary Barrier

54. Write the relationship between half value layer and the 10<sup>th</sup> value layer
55. Define workload
56. Define occupancy factor
57. Define Use factor
58. What is the average natural background radiation level in India and which part of India has the highest natural background radiation?
59. What is the minimum age to recruit a person as staff as and what is the minimum age to recruit as trainee per the RPR 2004?
60. Who is a classified Radiation worker as per RPR 2004?
61. What are the annual dose limits for extremities and eye for radiation worker?
62. What are the principles of radiation safety?
63. Define Annual Limit of Intake (ALI)
64. How would you estimate 10<sup>th</sup> Value layer from Half Value layer?
65. What are the factors that apparent radio-responsiveness of a tissue depends on?
66. Write a note on the importance of overall treatment time
67. AERB guidelines require a RAMP near a telecobalt unit. Mention the reasons for the same.
68. What are the AERB guidelines for providing conduit in a Teletherapy facility?
69. What are the AERB requirements for providing the room layout drawing and the site layout drawing for AERB approval?
70. What are the requirements for location of a teletherapy facility?
71. Define Transport Index (used for transport of Radioactive materials)
72. What are Type A and Type B pages?

### Section III

1. What are single and double strand breaks? Explain them with neat diagram (5)
2. Draw the cell survival curves for x-rays and for neutron and explain the relationship of dose with survival fraction (5)
3. What are  $D_0$  and  $D_{10}$  values on a cell survival graph? Explain how  $D_{10}$  is calculated from  $D_0$  value? (5)

4. Sketch the cell survival graph for single dose and for fractionated regimen and compare (5)
5. During the course of radiotherapy, a tumour containing  $10^9$  cells receives 40Gy. If the  $D_0$  is 2.2 Gy how many tumour cells will be left? (5)
6. With a cell survival curve explain  $\alpha$  and  $\beta$  values. What does  $\alpha/\beta$  denote? (5)
7. Write a note on the characteristics of the variation of radiosensitivity with cell age in mitotic cycle (5)
8. Sketch the cell survival graphs for different dose rates and explain the dose rate effect. (5)
9. Explain how the presence of oxygen alters the dose response (5)
10. Sketch and explain the graph showing the dependence of OER on LET (5)
11. Write a note on radiation weighting factors  $W_r$  giving the values for various types of radiation and the basics on which the ICRP has arrived at these values (5/10)
12. Calculate the equivalent dose ( $H_T$ ) for a person exposed to 20mGy of 1 Mev Neutron, 10mGy of  $\alpha$  rays and 5 mGy of 6MV x-rays (5)
13. Sketch the graph giving the variation of pulse amplitude against the applied voltage for gas filled detectors and indicate the regions on the graph and discuss the type of detectors at various regions. (10)
14. Write a note on internal amplification in gas filled detectors and the advantages of it (5)
15. Discuss the applications of gas filled detectors in Radiation protection and their relative merits. (5)
16. What is a G-M detector? How would you use it to detect  $\beta$  and  $\gamma$  radiations (5)
17. How would you determine the effective dose if a person is exposed non-uniformly? Give the values of tissue weighting factors for gonads, skin and thyroid. (5)
18. Explain the annual effective dose limits as prescribed by the Atomic Energy Regulatory Board (AERB) for i) radiation worker ii) member of the public iii) pregnant radiation worker (5)
19. Sketch the graph showing variation of Relative Biological Effectiveness (RBE) with LET. Explain with diagram, the reason for decrease in RBE for LET values beyond 100 keV/ $\mu$ . (5)
20. What is linear–quadratic model? Explain the advantage when compared to the TDF model. (5)

21. Derive the expression for Biological effective dose (BED) assuming a value of 'd' for dose per fraction and 'n' for number of fractions (5)
22. Sketch the Fe (Fractional Effect) plot and explain (5)
23. What are the 4Rs of radiobiology? and explain each one. Is there a 5<sup>th</sup> R,? if so explain the same.
24. Explain the relationship between LET and the Oxygen Enhancement ratio (OER) with a neat diagram (5)
25. Sketch the diagram comparing the relationship between OER, LET and RBE. (5)
26. With diagrams explain the direct and indirect action of radiation and explain which type of action is dominant for which type of radiation? (5/10)
27. What is potential tumour doubling time? and how is it calculated? (5)
28. Write down the effects of overall time and fraction size on early and late reactions (5)
29. What is the significance of  $\alpha/\beta$  and what is its unit? (5)
30. What are the syndromes of acute Total Body Irradiation? Explain each one of them giving the doses at which they appear and the symptoms. (10)
31. With diagram explain the radiation effects on Embryo and fetus at different stages of developmental period? (5)
32. Explain the effects of radiation of pregnant women at different stages of pregnancy. (5)
33. Explain the effect of exposure to large dose of 2.5Gy to the human embryo at different weeks of pregnancy.
34. Write a note of Radiation Cataractogenesis, mentioning the dose that causes cataract and the latent period.
35. What are acute and late effects? [5]
36. What are serial and parallel organs [5]
37. Calculate and compare the BED for i) 30 fractions of 2Gy per fraction, 5 days per week an overall time of 6 weeks ii) hyper fractionation, 70 fraction of 1.15 Gy, twice daily 6 hours apart 5 days per week an overall treatment time of 7 weeks [10]
38. Calculate the biological effective dose for early and late effects (assuming  $\alpha/\beta$  of 10 and 3 respectively) for a CHART regimen of 36 fractions of 1.5 Gy given in three fraction a day , 6 hours apart for 12 consecutive days with overall treatment time of 12 days. Comment on the values you arrive at.
39. Derive the equation for biologically effective dose giving allowance for Tumour Proliferation. [5]

40. An 80cm SAD, cobalt 60 external beam unit is to be installed on the ground floor. The capacity of the cobalt source head is 234 RMM. The activity of the source loaded is 150 RMM. Calculate the primary barrier thickness and the secondary barrier thickness assuming a workload of 45 patients per day. (The distance from the isocentre to the primary wall is 3 m on either side and to the secondary wall is 2.5 m, the cobalt unit is installed at 90° to the secondary wall) [10]
41. Sketch a typical facility for a 18 MV Linac to be installed on the ground floor and discuss the requirement for the treatment room door, material and thickness and radiation safety requirements of the treatment room. [10]
42. A dual-energy linac (6 and 18 MV) is to be on the ground floor. The Linac is to be used for IMRT treatments also. Calculate the Primary barrier thicknesses and the secondary barrier thickness for regular concrete (2.35 g/cc) assuming workload of 40 patient a day of which 20 are treated with IMRT using 6 MV beam and 10 3D CRT treatments each with 6 and 18 MV beams. (The isocentre is located at 3.5 m from the primary walls and 3 m from the secondary wall) . Also estimate the barrier thicknesses for high density concrete of density 4 g/cc [10]
43. Sketch a typical facility for a Ir -192, HDR brachytherapy facility indicating the barrier thicknesses for standard workload. Discuss briefly the calculation of barrier thicknesses and the radiation safety requirements [10]
44. Due to space constraint a 165 cm of concrete barrier is to be replaced with concrete and steel so that the total barrier thickness is 90 cm. Calculate the thickness of steel required. [5]
45. Write the AERB guideline for providing Air Condition in a Teletherapy facility [5]
46. Based on ICRP 60, the Atomic Energy Regulatory Board (AERB) has specified dose limits for whole body and organs; compare these dose limits as per ICRP and AERB for [5]
  - a. Radiation worker
  - b. Member of the Public
47. List the responsibilities of a Radiation Safety officer as per Radiation Protection Rule 2004.[5]
48. What are the requirements for decommissioning a radiation installation as per RPR 2004?[5]
49. What are the responsibilities of the licensee as per Radiation Protection Rule 2004 [5]

50. What are the categories for transport of radioactive materials? How are they classified? What are the transport indices for each category? [5]
51. Compare the dose limits of ICRP 60 and ICRP 103 and discuss the justification for the change in dose limits. [10]
52. What are occupational exposure dose limits of apprentices and trainees between 16 and 18 years of age as per the AERB regulations for whole body, lens, extremities and skin? [10]