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Basics of radiobiology

Exercises

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1. Physical effect of ionising radiation

The new PhD student in your lab is accidentally irradiated by a Co-60 source. The whole body absorbed dose is 15 Gy.

1. Compute the energy deposited in the body.
2. Derive the temperature increase in the body and judge which biological effects it may provoke?

2. Energy deposition by cosmic radiation

Cosmic muons deposit around $2 \text{ MeV}/(\text{g}/\text{cm}^2)$ in tissue.

How many charge-carrier pairs will be created in a human germ cell (diameter 0.05 mm) if it is hit by a cosmic-ray muon and if the energy for the production of a charge-pair is 30 eV ?

3. Mutation of a chromosome induced by cosmic radiation

What is the probability that cosmic muons cause chromosome (diameter $0.5 \mu\text{m}$) aberrations in a human germ cell (diameter $50 \mu\text{m}$)? The cosmic-ray-muon rate at sea level is roughly $1 \text{ muon} / (\text{cm}^2 \text{ min})$.

4. DDREF

We assume a hypothetical effect that has a cancer risk of 10% Sv^{-1} at high dose. Assuming a $\text{DDREF}=5$ for this specific effect, compute the number of induced effects for a population of 8 millions of habitants receiving a yearly mean dose of 1 mSv.

5. Effective dose

Compute the effective dose for the following situation:

- dose to the gonades: 2 mSv
- dose to the bone marrow: 1 mSv
- dose to the thyroid: 5 mSv
- dose to the remaining tissue : 0 mSv

Tissue/Organ	Weighting factor (2007)
Bone marrow	0.12
Breast	0.12
Colon	0.12
Lung	0.12
Stomach	0.12
Bladder	0.04
Esophagus	0.04
Gonads	0.08
Liver	0.04
Thyroid	0.04
Bone surface	0.01
Brain	0.01
Kidney	Remainder
Salivary glands	0.01
Skin	0.01
Remainder tissues	0.12 [†]

6. Biological effects

Indicate the main stages of the biological effects of radiation.

7. Deterministic effects

Indicate the deterministic effects in an individual receiving a whole-body dose of 0.1 Gy.

8. High dose irradiation

Indicate the effect of a whole-body dose of 10 Gy on an individual without any subsequent treatment.

9. Natural radiation induced cancer

Calculate for the Swiss population the annual number of induced cancers produced by natural radiation whose average effective dose is estimated at 5.5 mSv per year

10. Detriment

Which radiation effects are considered in evaluating the detriment?