Research Article

BIOMEDICAL Journal of Scientific & Technical Research

ISSN: 2574 -1241 DOI: 10.26717/BJSTR.2026.67.010436

Appendix A

Appendix A. Survival rate in the "single-Target single-Hit" model

When total cell number is defined as "n", "cell survival rate with a condition of average 1-Hit per 1-Target" means "repeat an event of the probability of 1/n (1-Hit/total cell number) for n times.

$$Pk(x) = nC_k \left(1-\frac{x}{n}\right)^{n-k} \left(\frac{x}{n}\right)^{k} \quad \text{(A-1)}$$

Pk(x): probability of x-Hits/Target with a radiation dose that induces x-Hits per a Target (Gy). n: total cell number.

When a dose that induces avarage 1-Hit per a Target (mean lethal dose in "1-Hit 1-Target" model) was irradiated, the survival rate (cells with 0-Hit) is described as follows;

$$S(1) = P0(1) = nC0\left(1-\frac{1}{n}\right)^{n} \left(\frac{1}{n}\right)^{0} \quad \text{(A-2)}$$

S(1): cell survival rate in "1-Target 1-Hit" model with a radiation dose that induces 1-Hit per a Target (MLD: mean lethal dose)

P0(1): probability of cells with 0-Hit with a radiation dose of mean lethal dose.

n: total cell number. e: the base of natural logarithm. ln(e) = 1.

In the case of n = 100.

$$S(1) = (1-1/100)^{100} = 0.3660 = 36.6\% \quad \text{(A-3)}$$

In the case of n = ∞.

$$S(1) = \lim_{n\to\infty}\left(1-\frac{1}{n}\right)^{n}, \text{ substitute } t = 1-\frac{1}{n}, \quad S(1) = \lim_{t\to\infty}(1-t)^{-1/t}, f(x) = \ln(x),$$

$$\ln S(1) = \lim_{n\to\infty} \ln\left(1-\frac{1}{n}\right)^{n} = \lim_{t\to\infty}\left(\frac{\ln(1+t)-\ln(1)}{t}\right)^{\square} = -f'(1) = -1$$

$$\therefore S(1) = e^{-1} = 0.3678(36.8\%)$$

In the case of a radiation dose that induces x-Hits per a Target is irradiated,

$$S(x) = \lim_{n\to\infty}\left(1-\frac{1}{n}\right)^{nx} = e^{-x} \quad \text{(A-4)}$$

S(x): cell survival rate in "1-Target 1-Hit" model with a radiation dose of x-Hits/Target.

Constant "k" is a characteristic number different according to species or cell lines.

So, survival curves of various microorganisms are described as follows;

$$S(x) = \lim_{n\to\infty}\left(1-\frac{1}{n}\right)^{nx} = e^{-kx} \quad \text{(A-5)}$$

ISSN: 2574-1241

DOI: 10.26717/BJSTR.2026.67.010436

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