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Channel Ratio in the Determination Of Two Gamma-Emitting Radioisotopes[1,2]

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The technique of gamma ray spectroscopy has gained wide use in distinguishing radioisotopes of different gamma ray energies. For example, the Cr^{51}-red cell survival can be studied simultaneously with Fe^{59} erythrokinetics (1), tissue uptake of K^{42} may be quantitated while Cu^{64} entry is also being followed (2), and Ba^{131} can be used as a nonabsorbed marker to quantitate the fecal excretion of I^{131}-labeled fats (3). Such applications have been accomplished by counting two gamma energy regions ("channels") and solving the appropriate simultaneous equations. Use of the ratio of the counts in the two channels has recently been found to simplify calculations in certain cases. Since no discussion of the technique has been noted, a brief description is given here.

THEORY

In Figure 1, L represents the counts in the lower channel, and U the counts in the upper channel of a gamma ray spectrometer. The discussion would be just as valid if there was no upper energy cut-off for the upper channel, and in certain simplifying situations. Let B represent the counts from one radioisotope in the upper channel, and D the counts from the second radioisotope in the lower channel. The quantities are related by the equations

$$U = B + cD, \tag{1}$$

and

$$L = aB + D, \tag{2}$$

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where a and c are constants. The ratio of channel counts gives

$$\frac{U}{L} = \frac{B + cD}{aB + D} ; \tag{3}$$

when B = O, U/L = c, and when D = O, U/L = 1/a. Hence, the constants can be readily evaluated by use of the channel ratio.

During studies of absorption from the gastrointestinal tract, it is of importance to determine the ratio of the absorbed radioisotope to the nonabsorbed marker.[3] This can be calculated using the channel ratio. Solving (1) and (2) for B and D in terms of U and L, gives

$$\frac{B}{D} = \frac{\frac{U}{L} - c}{1 - a\frac{U}{L}} . \tag{4}$$

The fraction of B in a particular sample is also calculable from the channel ratio

$$\frac{B}{B + D} = \frac{\frac{U}{L} - c}{\frac{U}{L}(1-a) + (1-c)} . \tag{5}$$

In the simplifying case of a small value for c, this approaches

$$\frac{B}{B + D} = \frac{\frac{U}{L}}{\frac{U}{L}(1-a) + 1} . \tag{6}$$

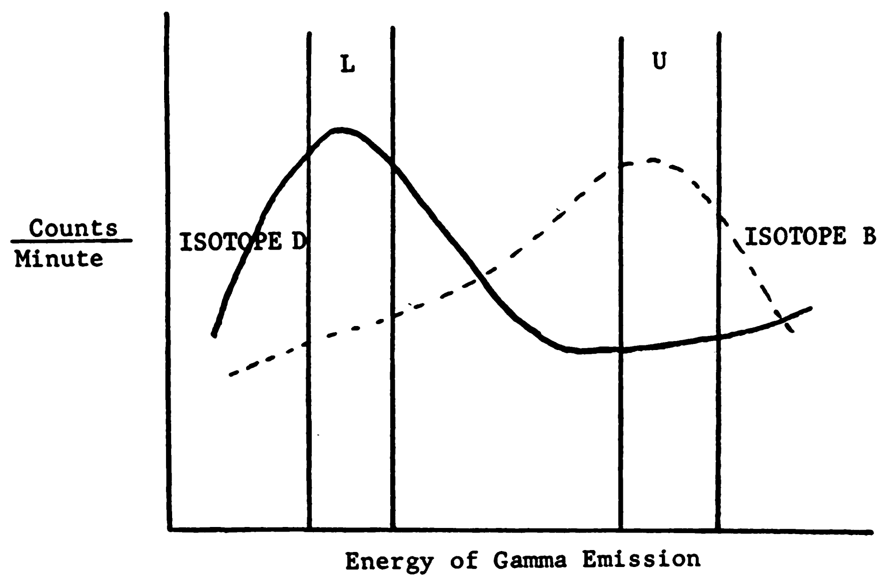

Fig. 1. Diagram of the energy spectra of two gamma emitting radioisotopes. L and U refer to the counts registered in the lower and upper cahnnels of a gamma ray spectrometer.

The above is the equation of a rectangular hyperbola. The reciprocal of equation (6) can be plotted on linear paper, and is an analogue of the Lineweaver-Burk treatment of the Michaelis-Menten equation. Equation (4) also simplifies in the case of a negligible value of c, to the inverse form

$$\frac{D}{B} = \frac{1}{\left(\frac{U}{L}\right)} - a \tag{7}$$

Again solving (1) and (2) for B and D, in terms of U and L there is obtained by letting $K = \frac{1}{1-ac}$

$$D = KL\left[1 - a\frac{U}{L}\right], \tag{8}$$

and

$$B = KL\left[\frac{U}{L} - c\right]. \tag{9}$$

SUMMARY

Calculation of the channel ratio, when two gamma-emitting isotopes are present, can be used to determine the constants in the equations relating channel counts to quantity of radioactivity, the amount of each radioisotope in a mixed sample, the ratio of the two radioisotopes, nad the fraction of either isotope in a mixture.

REFERENCES

1. WEINSTEIN, I. M.; BEUTLER, E.: The Use of Cr^{51} and Fe^{59} in a Combined Procedure to Study Erythrocyte Production and Destruction in Normal Human Subjects and in Patients with Hemolytic or Aplastic Anemia. *J. Lab. and Clin. Med.* **45**:616, 1955.
2. SPENCER, R. P.; MITCHELL, T. G.: Simultaneous Uptake of Radioactive Copper and Radioactive Potassium by Rat Brains. *J. Neuropath. and Exp. Neurol.* **17**:479-483, 1958.
3. SEIFE, B.: Radioactivity Inert-Indicator Method for Intestinal Absorption Utilizing Differential Counting. *J. Lab. and Clin. Med.* **59**:513, 1962.