# One Tissue Compartment Model for Radioligand Kinetics

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## 1 Model setup

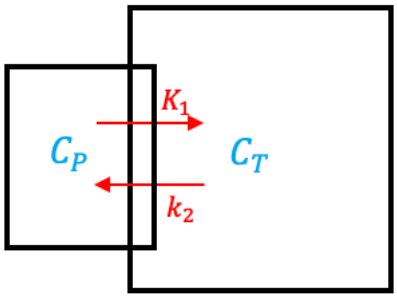


Figure 1: One-tissue compartment model. P: plasma (including free plus protein bound). T: tissue (including free, specific bound, and non-specific bound.)

This document is based on [2] Appendix B.
The differential equation for the radioligand kinetics is

$$\frac{\mathrm{d}C_T(t)}{\mathrm{d}t} = K_1 C_P(t) - k_2 C_T(t)\,, \tag{1}$$

where

- $C_P$: metabolite-corrected plasma concentration (kBq/ml).
- $C_T$: concentration of radioligand in the tissue (i.e. free plus specifically bound plus non-specifically bound) (kBq/ml).
- $K_1$: rate constant for transfer from arterial plasma to tissue ($\mathrm{ml} \cdot \mathrm{ml}^{-1} \cdot \mathrm{min}^{-1}$).
- $k_2$: rate constant for transfer from ND compartment to plasma compartment ($\mathrm{min}^{-1}$).

## 2 Solution

Take Laplace transform on both side, along with the initial conditions $C_T(0) = 0$, we get

$$s\bar{C}_T(s) = K_1\bar{C}_P(s) - k_2\bar{C}_T(s)\,.$$

That give us

$$\bar{C}_T(s) = \frac{K_1}{s + k_2}\bar{C}_P(s)\,.$$

The solution is

$$C_T(t) = K_1 C_P(t) \otimes e^{-k_2 t}\,.$$

## 3 Volume of distribution

The volume of distribution $V_D$ of the tracer can be calculated as

$$V_D = \frac{K_1}{k_2}\,.$$

If we are more interested in estimating $V_D$ instead of $k_2$, we can replace $k_2$ by $K_1/V_D$, the solution then becomes

$$C_T(t) = K_1 C_P(t) \otimes e^{-(K_1/V_D)t}\,.$$

Then we do curve fitting with respect to $K_1$ and $V_D$.

## References


[1] Robert B Innis, Vincent J Cunningham, Jacques Delforge, Masahiro Fujita, Albert Gjedde, Roger N Gunn, James Holden, Sylvain Houle, Sung-Cheng Huang, Masanori Ichise, et al. Consensus nomenclature for in vivo imaging of reversibly binding radioligands. *Journal of Cerebral Blood Flow & Metabolism*, 27(9):1533–1539, 2007.

[2] AA Lammertsma, CJ Bench, SP Hume, S Osman, K Gunn, DJ Brooks, and RSJ Frackowiak. Comparison of methods for analysis of clinical [11c] raclopride studies. *Journal of Cerebral Blood Flow & Metabolism*, 16(1):42–52, 1996.