Pharmacokinetics: 1st order elim

In biologic systems, most drugs are eliminated via zero- or first- order kinetics. With zero order kinetics, a constant, certain mass of drugs are eliminated per unit time. This means the half-life of a substance is proportional to the concentration of the substance. Substances eliminated via zero-order kinetics include alcohol, phenytoin, and salicylates.

Most substances are eliminated via first-order kinetics in which the rate of clearance/elimination is proportional to the concentration of the substance. This means the half-life is a constant. It is possible for the concentration of some substances to be high enough that its clearance method becomes saturated and for a time, the substance follows zero-order kinetics.

Mathematically these kinetics can be described as:

Zero-order kinetics:

$$\frac{d[A]}{dt} = -k$$
$$[A]_t = [A]_0 - kt$$

First-order kinetics:

$$\frac{d[A]}{dt} = -k[A]$$
$$\ln([A]_t) = \ln([A]_0) - kt$$

Which can be rearranged to

$$[A]_t = [A]_0 e^{-kt}$$

Where $[A]_t$ is the concentration of a substance at time t, $[A]_0$ is the starting concentration of a substance, and k is system-specific elimination constant.

Second and higher order reactions exist but are rare enough in anesthetic practice (and not an ABA keyword) that I wouldn't worry about them.

Further reading: Kim, TK. Shinju, O. Johnson, KB. Miller's Anesthesia, 9th ed. "Basic Principles of Pharmacology". 18: 462-482. Elsevier: 2020

Wikipedia: https://en.wikipedia.org/wiki/Rate_equation