This lecture is designed to discuss **compartmental modeling** in pharmacokinetics (PK). Instead of viewing the body as a complex web of millions of cells, it is simplified to spaces referred to as "**compartments**" to predict how a drug moves through the system.

1. What is a "Compartment"?

In PK, a compartment is **not** a real anatomical organ like the liver or lungs. Instead, it is a **mathematical concept** representing a group of tissues that have similar blood flow and drug affinity.

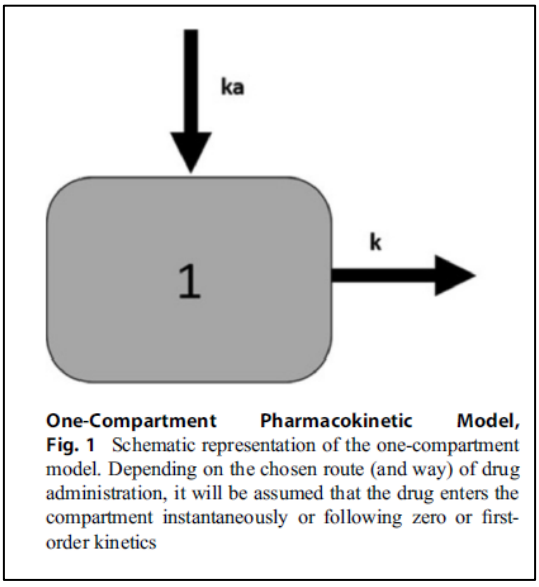
- **Well-Perfused Tissues:** Organs with high blood flow (heart, liver, kidneys) usually group together.
- **Poorly-Perfused Tissues:** Areas with lower blood flow (fat, muscle, bone) form another group.

2. The One-Compartment Model

This is the simplest way to describe drug behavior. We imagine the entire body as a **single, uniform tank** of fluid.

Key Assumptions:

1. **Instant Distribution:** As soon as the drug enters the body (e.g., via IV injection), it spreads perfectly and instantly throughout the entire volume.
2. **Homogeneity:** The concentration in the blood is assumed to be the same as the concentration in the tissues.
3. **Elimination:** The drug leaves the "tank" at a rate proportional to how much is left (First-Order Kinetics).

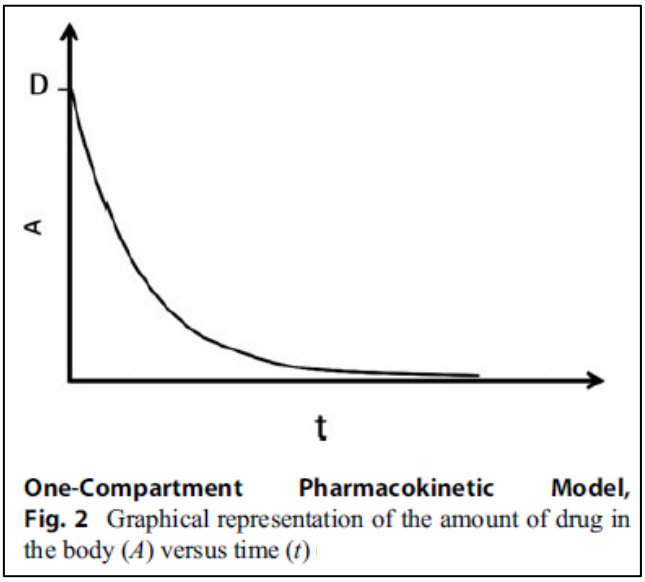


One-Compartment Pharmacokinetic Model, Fig. 1 Schematic representation of the one-compartment model. Depending on the chosen route (and way) of drug administration, it will be assumed that the drug enters the compartment instantaneously or following zero or first-order kinetics

The Math & Graph:

If you plot the plasma concentration (C) over time (t) after an IV bolus, it follows a simple exponential decay:

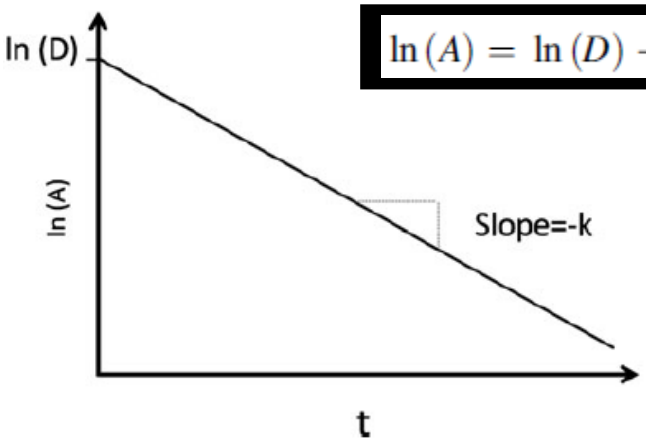
$$C = C_0 \cdot e^{-kt}$$



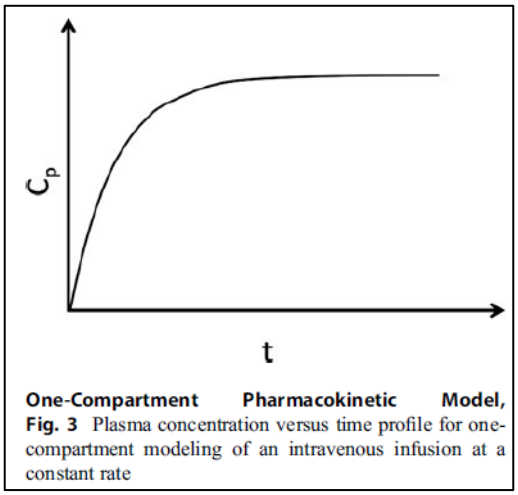
One-Compartment Pharmacokinetic Model, Fig. 2 Graphical representation of the amount of drug in the body (A) versus time (t)

- **Log-Scale Graph:** On a semi-logarithmic plot, this appears as a **single straight line**. The slope of this line tells you the elimination rate (k).

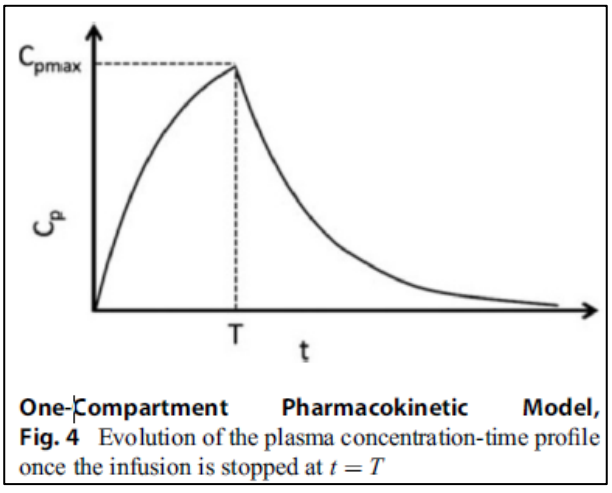
$$\ln(A) = \ln(D) - kt$$



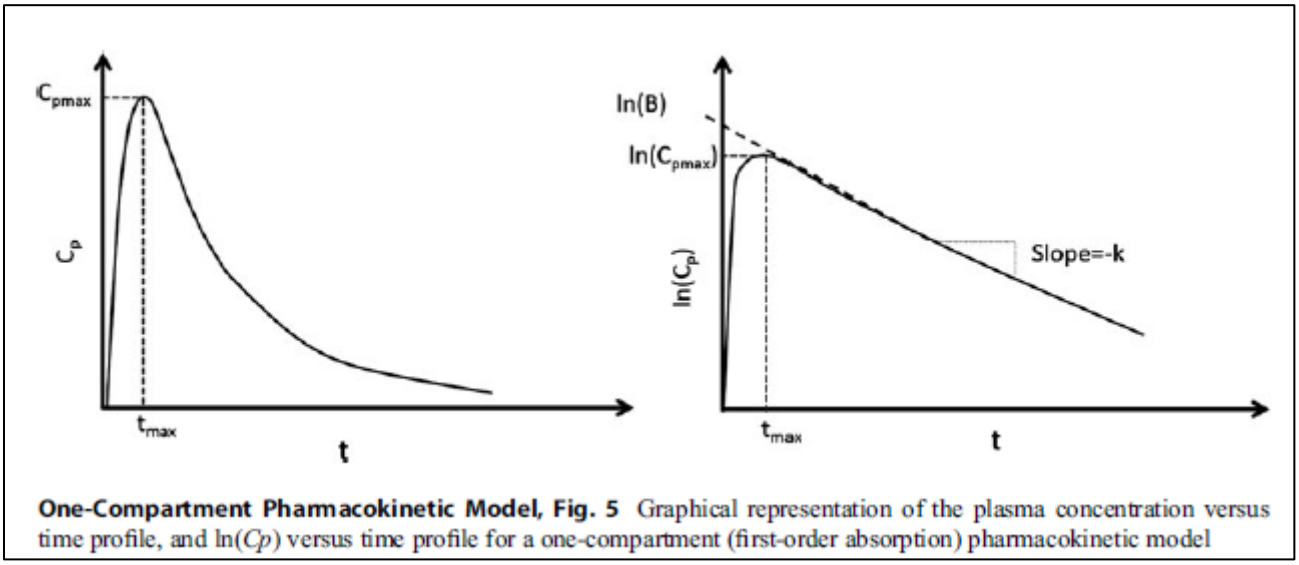
ln(A) versus t according to the one-compartment pharmacokinetic model, bolus intravenous administration



One-Compartment Pharmacokinetic Model, Fig. 3 Plasma concentration versus time profile for one-compartment modeling of an intravenous infusion at a constant rate



One-Compartment Pharmacokinetic Model, Fig. 4 Evolution of the plasma concentration-time profile once the infusion is stopped at $t = T$



One-Compartment Pharmacokinetic Model, Fig. 5 Graphical representation of the plasma concentration versus time profile, and ln(*Cp*) versus time profile for a one-compartment (first-order absorption) pharmacokinetic model

Why do we care?

Modeling allows clinicians to calculate:

- **Volume of Distribution (Vd):** How much of the drug is "hiding" in tissues vs. staying in the blood:

$$\mathbf{Vd = Total\ dose / C_0}$$

- **Clearance (Cl):** How fast the body gets rid of the drug:

$$\mathbf{Cl_t = k \cdot Vd = [\ ln(2)/t_{1/2}\ ].\ Vd}$$

- **Half-life ($t_{1/2}$):** How long it takes for the concentration to drop by half, which dictates how often a patient needs a dose:

$$t_{1/2} = \frac{\ln(2)}{k}$$