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SIMIODE Systemic Initiative for Modeling Investigations and Opportunities with Differential Equations

STUDENT VERSION
DRUG BOLUS

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STATEMENT

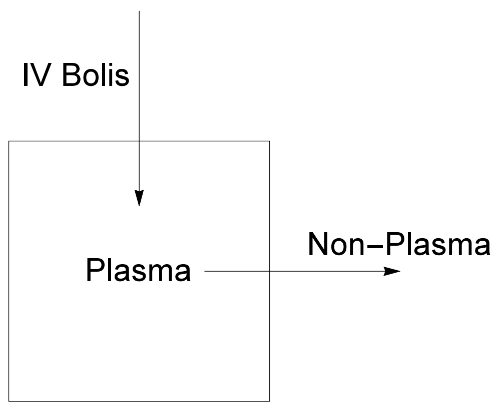

Figure 1. Diagram of drug flow into plasma of a human.

A dose of 500 mg of a drug was administered to a healthy volunteer as an intravenous bolus (IV bolus), i.e. single injection. Figure 1 offers a diagram which shows the path of the drug. This is called a one-compartment model and it is presumed that the drug enters the compartment all at once in the case of an IV Bolus and leaves the plasma (say for the tissues of the body where it is destined to perform its mission) at a rate proportional to the concentration in the plasma. See Figure 1.

Seven blood samples were collected at 1, 2, 3, 4, 6, 10, and 12 hours. Plasma was separated from each blood sample and analyzed for drug concentration. The collected data are shown in Table 1. The first coordinate is time from intake of drug in hours, while the second coordinate is concentration in mg/L of the drug in the plasma.

Time (hr)	1	2	3	4	6	10	12
mg/L Drug in Plasma	12.72	10.8	8.26	7.02	4.63	1.99	1.44

Table 1. Data on concentration of a drug in a patient's plasma in hours from intravenous bolus injection.

Some basic information might help. The average human being has about 5 liters of blood of which some 55% is referred to as plasma or serum. It is the yellow liquid found in blood when the platelets and red and white blood cells are separated out through centrifuge.

Use the data in Table 1 and the information in Figure 1 to address these issues.

a) build a differential equation model for this drug elimination,

b) estimate the initial concentration of the drug in the plasma,

c) estimate the elimination rate constant, i.e. the rate constant with units 1/h which is the constant of proportionality in your differential equation model, and

d) confirm your model in some manner.