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STUDENT VERSION

Drug Model for Aspirin Absorption

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STATEMENT

How does the human body absorb some drugs, particularly aspirin? That is the question for our study.

1 ASPIRIN ABSORPTION

Activity 1: First Thoughts on Modeling Drug Absorption

(1.1) Typically when a drug is administered to an individual, the amount of the drug in mg, A(t), in the body changes over time in minutes. *Pharmacokinetics* is "the science of the kinetics of drug absorption, distribution, and elimination (i.e. metabolism and excretion.)" [1, p. 4] Write an equation that corresponds to a **constant release** of the drug from an ingested tablet into the body over time.

$$\frac{dA}{dt} = \tag{1}$$

(1.2) Identify the following for your equation, or write "none": independent variable(s); dependent variable(s); constant(s); parameter(s).

(1.3) For a drug that is released into the body at a constant rate, would you expect the amount of drug in the body to increase, stay the same, or decrease with time, at least for a while? What value would you expect for the initial amount of drug in the body?

Activity 2: A General Model

(2.1) One general model of drug amount in the body is given by

$$\frac{dA}{dt} = k. \tag{2}$$

Use your mathematical background: $\frac{dA}{dt}$ represents the ____ __ ____ of the amount of drug in the body over time, in units of _____ .

(2.2) A "zero-order reaction" in pharmacokinetics is exemplified by (2). Classify this differential equation using mathematical terms. Determine a general solution.

Activity 3: ASA Model and Specific ASA Situation.

ASA stands for *acetylsalicylic acid*, which can be used to treat pain and other conditions. It is the primary ingredient in Bayer®Aspirin™. Note that Aspirin is trademarked in some countries. Other ASA variants include BC®Powder and Excedrin®.)

A patient swallows a tablet that contains 325 mg of ASA. A specific model of drug amount in this case is given below from [1].

$$A(t) = 0.86t - 0.04 \tag{3}$$

(3.1) Is this a zero-order reaction?

(3.2) The tablet takes a while to dissolve. What are the smallest and largest amounts of ASA in the body? At what times do these occur? Determine a realistic time interval for (3) to be in effect and graph the resulting realistic $A(t)$.

(3.3) Give the differential equation form of (3) and provide a realistic initial condition.

(3.4) Create a "phase plane", which in the context of our differential equation, is a graph with $A(t)$ on the horizontal axis and the rate of change of the drug amount $\frac{dA}{dt}$ on the vertical axis.

(3.5) What about the phase plane might indicate that the reaction is "zero-order"?

REFERENCES

[1] Shargel, L. and A. Yu 2016. *Applied Biopharmaceutics and Pharmacokinetics. 7th ed.* New York: McGraw Hill.