1. Problem 1

For drugs that are fat-soluble, a three-compartment model is sometimes used.

Set up a discrete three-compartment model with the following assumptions:

- The first compartment represents the digestive tract. As soon as the medication is ingested, assume the quantity in this compartment instantly reaches the quantity ingested.
- The second compartment represents the bloodstream. Once in the bloodstream, the medication can be absorbed by fatty tissue, or metabolized.
- The third compartment represents the fatty tissue. Once absorbed from the bloodstream, the substance can break down or be re-absorbed into the bloodstream.

Assume the following values:

- Once in the digestive tract, 13% of the substance is absorbed into the bloodstream every 15 minutes.
- Once in the bloodstream, 4% is absorbed into fatty tissue each hour, while 11% is metabolized.
- Once in the fatty tissue, 2% is broken down every hour, while 1% is reabsorbed into the bloodstream.

Suppose 400 mg of a fat-soluble drug is given to a patient at 8AM. How much remains after 4 hours? After 8 hours? What is the breakdown in the three locations?

If the patient is given a second 400 mg dose after 8 hours, what is the highest total amount of the drug in the body? What is the peak in each of the three locations?

2. Problem 2

For drugs that are fat-soluble, a three-compartment model is sometimes used.

Set up a discrete three-compartment model with the following assumptions:

- The first compartment represents the digestive tract. As soon as the medication is ingested, assume the quantity in this compartment instantly reaches the quantity ingested.
- The second compartment represents the bloodstream. Once in the bloodstream, the medication can be absorbed by fatty tissue, or metabolized.
- The third compartment represents the fatty tissue. Once absorbed from the bloodstream, the substance can break down or be re-absorbed into the bloodstream.

Assume the following values:

- Once in the digestive tract, 25% of the substance is absorbed into the bloodstream every 15 minutes.
- Once in the bloodstream, 3% is absorbed into fatty tissue each hour, while 5% is metabolized.
- Once in the fatty tissue, 2% is broken down every hour, while 1% is reabsorbed into the bloodstream.

Suppose 400 mg of a fat-soluble drug is given to a patient at 8AM. What is the breakdown of the material (digestive tract, bloodstream, fatty tissue) after 4 hours? After 16 hours?

How long does it take for 95% of the drug to be eliminated?

3. Problem 3

A three compartment model can be used to describe the elimination of a fat-soluble organic compound.

Set up a discrete three-compartment model with the following assumptions:

- The first compartment represents the digestive tract. As soon as the substance is ingested, assume the quantity in this compartment instantly reaches the quantity ingested.
- The second compartment represents the bloodstream. Once in the bloodstream, the substance can be absorbed by fatty tissue, or metabolized.
- The third compartment represents the fatty tissue. Once absorbed from the bloodstream, the substance can break down or be re-absorbed into the bloodstream.

Assume the following values:

- Once in the digestive tract, 16% of the substance is absorbed into the bloodstream every 30 minutes.
- Once in the bloodstream, 6% is absorbed into fatty tissue each hour, while 5% is metabolized.
- Once in the fatty tissue, 2% is broken down every hour, while 3% is reabsorbed into the bloodstream.

A poison control center receives a call that a child has ingested 5 grams of a fat-soluble liquid hydrocarbon. What is the breakdown in the child's system after 3 hours? After 8 hours?

What is the maximum quantity observed in the bloodstream? In the fatty tissue?

How long will it take for 90% of the substance to be removed from the system (by metabolism or breakdown)?

4. Problem 4

For drugs that are fat-soluble, a three-compartment model is sometimes used. To determine the rate of elimination, 400mg of a fat-soluble drug is given to a patient every 24 hours.

Set up a discrete three-compartment model with the following assumptions:

- The first compartment represents the digestive tract. As soon as the medication is ingested, assume the quantity in this compartment instantly reaches the quantity ingested.
- The second compartment represents the bloodstream. Once in the bloodstream, the medication can be absorbed by fatty tissue, or metabolized.
- The third compartment represents the fatty tissue. Once absorbed from the bloodstream, the substance can break down or be re-absorbed into the bloodstream.

Assume the following values:

- Once in the digestive tract, 25% of the substance is absorbed into the bloodstream every 15 minutes.
- Once in the bloodstream, 3% is absorbed into fatty tissue each hour, while 5% is metabolized.
- Once in the fatty tissue, 2% is broken down every hour, while 1% is reabsorbed into the bloodstream.

What is the maximum and minimum amount of the drug in the patient's system on day 15 of the trial? On day 25?

Did the extreme values on a given day appear to stabilize?