Drugs

Witt

Grade: 95 (5 points for structure of answers to 1, 2, 3, and 4)

Approriate Introduction	Looks good.
Explanation of prednisone	Nicely done.
Biological half-life	Good here as well.
Answers to 1, 2, 3, and 4	I appreciate that you took the time to get the LaTeX commands for the lists of answers, but the project description was specific in saying that your answers to these questions should be in paragraph form and not simply listed like an ordinary homework problem.
Proper formatting	Bravo on using the list environments to detail your answers to the questions. Unfortunately, as I said above, the answers were to be given in paragraph form.

List of Comments

Prednisone Project

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Abstract

In this project we were asked to construct a recursive model for the amount of a drug that is present in a patient's bloodstream after a certain amount of time and under certain conditions. Specifically, we were asked to learn more about the drug Prednisone.

Prednisone

Prednisone is a synthetic corticosteroid drug, meaning it is a steroid that helps things like immune response, stress relief, and regulating inflammation. Hence, Prednisone is used to treat certain inflammatory diseases, autoimmune diseases, and some types of cancer.

Biological Half-life

An important factor in this project is the biological half-life.All drugs, including Prednisone, have a biological half life. The biological half-life is the point in time where half of the pharmacological activity of the original dose of the drug has left the body through the kidneys and liver. For Prednisone, the biological half-life is one hour.

Prednisone Instructions

From the project description: "Prednisone is often prescribed for acute asthma attacks and suppresses the immune system. For 5 mg tablets, typical instructions are: 'Take 8 tablets the first day, 7 the second, and decrease by one tablet each day until all tablets are gone.'"

Procedure/Questions

Below are the models for different scenarios/time-periods of Prednisone in the body.

1. Write formulas involving x, for the amount of Prednisone in the body:

   (a) 24 hours after taking the first dose (of 8 tablets), right before taking the second dose (of 7 tablets).

      i. The formula I used is $x(t) = A_{d_0}(0.5)^t$

         A. A_{d_0} = amount of the dose of Prednisone (in mg)

         B. t = time (in hours)

         C. 0.5 = biological half-life

      ii. So, $x(24) = 40(0.5)^{24} =$ **$2.384e^{-6}$ mg of Prednisone**

(b) Immediately after taking the second dose (of 7 tablets).

i. The formula I used is $A_{d_0} = A_{d-1_f} + 5(n - (d-1))$

A. A_{d_0} = amount of Prednisone immediately after the dth dose

B. A_{d-1_f} = amount of Prednisone 24 hours after the last dose (in mg)

C. n = starting number of tablets = 8 tablets

D. d = dose that the patient is on = 2

ii. So, $A_{d_0} = 2.384e^{-6} + 35$ mg **= 35.000002384 mg of Prednisone**

(c) Immediately after taking the third dose (of 6 tablets).

i. The formula I used is $A_{d_0} = A_{d-1_f} + 5(n - (d-1))$

A. A_{d_0} = amount of Prednisone immediately after the dth dose

B. A_{d-1_f} = amount of Prednisone 24 hours after the last dose (in mg)

C. n = starting number of tablets = 8 tablets

D. d = dose that the patient is on = 3

ii. So, $A_{d_0} = 35.000002384(0.5)^{24}+30 = 2.086e^{-6}+30 =$ **30.000002086 mg of Prednisone**

(d) Immediately after taking the eighth dose (of 1 tablet).

- To solve this, we must solve for the amount of Prednisone immediately after taking each dose. We can do this given the previous formula $A_{d_0} = A_{d-1_f}+5(n-(d-1))$, where A_{d_0} = the amount of Prednisone immediately after the dth dose, A_{d-1_f} = the amount of Prednisone 24 hours after the last dose (in mg), n = the starting number of tablets (8 tablets), and d = the dose that the patient is on. To solve for A_{d-1_f}, we use the other previous formula, $x(t) = A_{d_0}(0.5)^t$, where t = the time in hours.

i. A_{4_0}: $A_{3_f} + 5(8 - (4 - 1)) = 30.000002086(0.5)^{24} + 25 = 1.79e^{-6} + 25 = 25.00000179$ mg of Prednisone immediately after taking the 4th dose

ii. A_{5_0}: $A_{4_f} + 5(8 - (5 - 1)) = 25.00000179(0.5)^{24} + 20 = 1.49e^{-6} + 20 = 20.00000149$ mg of Prednisone immediately after taking the 5th dose

iii. A_{6_0}: $A_{5_f} + 5(8 - (6 - 1)) = 20.00000149(0.5)^{24} + 15 = 1.19e^{-6} + 15 = 15.00000119$ mg of Prednisone immediately after taking the sixth dose

iv. A_{7_0}: $A_{6_f} + 5(8 - (7 - 1)) = 15.00000119(0.5)^{24} + 10 = 8.94e^{-7} + 10 = 10.00000089$ mg of Prednisone immediately after taking the seventh dose

v. A_{8_0}: $A_{7_f} + 5(8-(8-1)) = 10.00000089(0.5)^{24} + 5 = 5.96e^{-7} + 5 =$ **5.000000596 mg of Prednisone immediately after taking the eighth dose**

(e) 24 hours after taking the eighth dose.

- Use this previous formula: $x(t) = A_{d_0}(0.5)^t$
  i. A_{d_0} = amount of the dose of Prednisone (in mg)
    A. In this case, the amount of Prednisone will be the amount in the system immediately after taking the eighth dose, or 5.000000596 mg of Prednisone.
  ii. t = time (in hours)
  iii. 0.5 = biological half-life
- $x(24) = 5.000000596(0.5)^{24} =$ **$2.98e^{-7}$ mg of Prednisone**

(f) n days after taking the eighth dose.

- Formula: $\mathbf{x(n) = 5.000000596(0.5)^{24n}}$
- You can solve this using a process similar to part 1e). The only difference in the formula is using the variable n and making $t = 24$. n is a variable for the number of days passed. By doing this, you are solving for the number of days, but in hours. To convert to days, divide your final answer by 24.

2. If a patient takes all the Prednisone tablets as prescribed, how many days after taking the eighth dose is there less than 3% of a Prednisone tablet in the patient's body?

- We know that one Prednisone tablet is 5 mg, so 3% of that tablet is $.03(5) = .15$ mg.
- We must set up an equation: .15 mg $> 5.000000596(0.5)^{24n}$, where $n =$ the number of days.
  (a) using a calculator, we find that $\mathbf{n = .210787}$ **days or 5.059 hours.**

3. A patient is prescribed n tablets of Prednisone the first day, $n-1$ the second, and one tablet fewer each day until all the tablets are gone. Write a formula that represents T_n, the number of Prednisone tablets in the body immediately after taking the final dose.

   - To solve for this, I used formulas similar to the ones above:

     (a)
     $$A_{d_0} = A_{d-1_f} + 5(n-(d-1))$$

     (b)
     $$T_n = \frac{A_{8_0}}{5}$$

     (c)
     $$T_n = \frac{5.000000596}{5} = 1.000000119$$

     (d) **There are 1.000000119 tablets in the body immediately after taking the final dose.**

   - Where A_{d_0} is the amount of Prednisone immediately after taking the dth dose, A_{d-1_f} is the amount of Prednisone 24 hours after the last dose (in mg), n is the starting amount of tablets (8), t is time in hours, and d is the dose that the patient is on. NOTE: You divide by 5 because the formula models the mg of Prednisone in the body, not tablets. Dividing by 5 (mg) converts the model to number of tablets in the body.

4. If a patient accidentally takes all the Prednisone tablets at once, what percentage of a Prednisone tablet will be present in the patient's body? How long will it take for there to be less than 3% of a Prednisone tablet in the patient's body?

   - If the patient takes all 36 Prednisone tablets at once, there are 180 mg ($36 * 5$ mg), or 3600% of a Prednisone tablet in the body.

- To solve this, we must set up another equation: $180(0.5)^t = .15$ mg, where t is the time in hours that it will take to be less than 3% of a Prednisone tablet in the body.
  (a) using a calculator, we find that $\mathbf{n = 10.229}$ **hours.**

Conclusion

I enjoyed this project because the topic was very interesting to me. I had never learned about modeling the amount of a drug in a human body at a point in time, and doing this project made me realize how much has to be considered when writing/administering the drug instructions. One still has to consider the amount of the drug that is still in the body before taking another dose. This concept confused me for quite some time and made writing the formulas much harder. For example, question three was the hardest question for me. While I believe I got the correct numerical answer, deriving a formula proved most challenging, and I ended up deriving an extremely simple and minimal formula. Otherwise, when I began to understand the concept, the rest of the project was fairly straightforward. In addition, I found that writing many of these answers in paragraph form was confusing and hard to follow, so I stuck to writing the answers as a list, but with explanations integrated into the list.

Overall, I extremely enjoyed working on this project. This topic has been the most interesting project topic so far, and it has also been the most challenging project for me so far.