1. a. The best fitting model to the data is given by

$$P(t) = 0.05039t^4 - 1.335t^3 + 9.144t^2 - 2.699t + 51.38.$$

b. The derivative is given by

$$\frac{dP}{dt} = 0.20156t^3 - 4.005t^2 + 18.288t - 2.699.$$

c. The relative minima are $(0.1526, 51.18)$ and $(12.936, 67.79)$, while the relative maximum is $(6.781, 143.82)$. The population at $t = 0$ is $P(0) = 51.38$, while the population at $t = 15$ is $P(15) = 113.66$. It follows that the absolute minimum occurs at $t = 0.1526$ weeks with a minimum population of $P = 51.18$, while the absolute maximum occurs at $t = 6.781$ weeks with a maximum population of $P = 143.82$.

d. The second derivative is given by

$$\frac{d^2P}{dt^2} = 0.60468t^2 - 8.010t + 18.288.$$

The second derivative is zero (derivative has a relative maximum or minimum) at $t = 2.932$ with $P'(2.932) = 21.572$ insects/m^2/week and $t = 10.314$ with $P'(10.314) = -18.973$ insects/m^2/week. The derivatives at the endpoints are $P'(0) = -2.699$ insects/m^2/week and $P'(15) = 50.76$ insects/m^2/week. It follows that the maximum growth rate occurs at the end of the week with $P'(15) = 50.76$ insects/m^2/week, while the minimum occurs at $t = 10.314$ with $P'(10.314) = -18.973$ insects/m^2/week.

2. a. The best model for the amount of drug in the body is

$$D(t) = 7.7784e^{-0.1077t}.$$

The sum of square errors between the model and the data is 0.78767.

b. The best parameters fitting the data are $B = 297.97$ and $q = 0.07603$, giving the best pharmakinetic model as

$$C(t) = 297.97(e^{-0.07603t} - e^{-0.1077t}).$$

The sum of square errors between the model and the data is 1.0517. With this exponential model, the derivative is

$$C'(t) = -22.655e^{-0.07603t} + 32.091e^{-0.1077t}.$$

The percent error at $t = 10$ days is -1.007%, while the percent error at $t = 20$ days is -0.1299%. The maximum concentration of the cytokine occurs at $t_{max} = 10.995$ with $C(t_{max}) = 37.979$ ng/dl. See graph below.

c. The best parameters fitting the data are $K = 9.3975$ and $r = 0.09090$, giving the best pharmakinetic model as

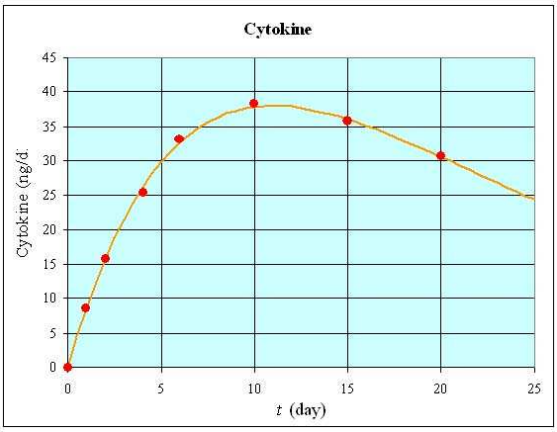
$$R(t) = 9.3975te^{-0.09090t}.$$

The sum of square errors between the model and the data is 1.0137. This gives the smaller sum of square errors, but only by an insignificant amount, making the models equally good. The percent

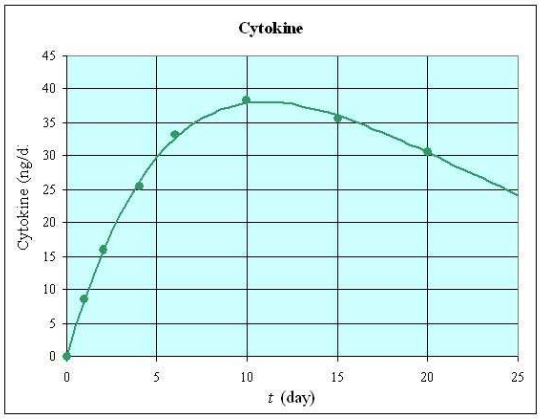
error at $t = 10$ days is -0.8768%, while the percent error at $t = 20$ days is -0.2820%. With this Ricker's model, the derivative is

$$R'(t) = 9.3975\, e^{-.09090t}(1 - 0.09090t).$$

From this model, the maximum concentration of the cytokine occurs at $t_{max} = 11.001$ with $R(t_{max}) = 38.032$ ng/dl. See graph below.



$C(t)$ from Part b



$R(t)$ from Part c