

Name: _____

Math130: Biomodule #3

Aphids feed on the sap of a common ornamental garden plant called Lupine. The aphids puncture phloem vessels in the lupine and feed on its sap. If the total amount of sap eaten by an aphid is given by:

$$s(t) = 4t - 0.02t^2$$

where $s(t)$ is measured in μL and t is time in minutes.

- 1. (1pt) What is the rate of sap uptake by an aphid at 10 minutes of feeding?**

One of the fundamental concepts of evolutionary biology is that of natural selection, where organisms with genes that are best suited for their environment have a better chance of survival and are more likely to reproduce. The more offspring an organism has, the greater the frequency of their genes. However, in organisms where parental care is costly (e.g., humans!), there is a tradeoff between having more offspring and being able to provide sufficient resources to ensure the survival of each offspring. In birds, the size of the clutch (# of eggs in the nest) is a good example of this tradeoff, and can be modeled by the equation $P(N) = 1 - 0.1N$, where $P(N)$ is the probability of survival for each chick and N is the clutch size.

- 2. (1pt) In words, what happens to the likelihood of survival for each chick as the number of eggs laid increase?**

- 3. (2pts) Determine the average rate of change of chick survival if the typical number of eggs in a clutch ranges from 3-7 Explain your answer.**

4. (3pts) The total number of offspring that are likely to survive, $S(N)$, can be modeled as the product of the clutch size and the probability of survival. What is the instantaneous rate of change at $N=4$, $N=5$, and $N=6$?

5. (2pts) Based on your answer from the previous question and what you know about instantaneous rates of change, predict the optimal clutch size for a female bird? Explain how you came to this conclusion.

6. (1pt) How many chicks can you expect to survive in a clutch of the optimal size?