Name: _____ KEY _____

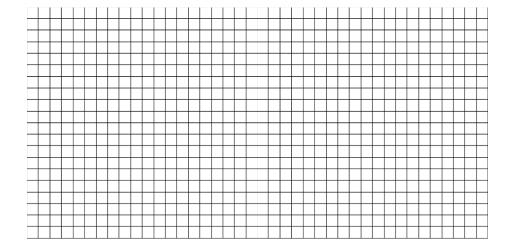**Math130: Biomodule #7**
***SHOW YOUR WORK!***

1. Plants are photoautotrophic which means they produce their own food using light. Photosynthesis is the mechanism by which plants produce food using water, a carbon source, and sunlight. In London, the number of hours of daylight follows roughly $L(t) = 12 - 4.5\cos(2t)$ where $t$ represents time for which $2\pi$ corresponds to one year, and the shortest day is December 21st (the winter solstice). A plant unfolds its leaves in the spring in response to the *change* in day length.

   a. Write an equation that describes when a plant unfolds its leaves. (1pt)

   b. What is the value of $t$ that produces the longest day? (1pt)

   c. How many hours of daylight are there on the longest day? (1pt)

   d. When, throughout a year, would it be easiest for the plant to detect changes in day length? (1pt)

   e. Graph $L(t)$ and $L'(t)$ on the same graph and check your previous result. (2pts)

2. Photopigments in the eye can be 'bleached' by intense light, leading to temporary color-blindness. The blindness is only temporary because the pigments are regenerated. The proportion P of unbleached (functional) photopigments can be described as a function of the time that the pigments are exposed to intense light: $P(t) = 1 - P_0\left(e^{-\frac{t}{r}}\right)$ where $P_0$ is the proportion of pigments bleached at time 0 and $r$ is a constant related to the time it takes for pigments to regenerate.

   a. Find a function that describes the rate of pigment bleaching. Show your work and simplify the resulting function. (1pt)

   b. Consider an animal that varies its number of photopigments according to time of day by the following equation:
   $$N(t) = 1.5 \sin\left(\frac{\pi}{12}(t - 6)\right) + 5$$
   where $t$ is measured in hours. Find the function that describes the rate of photoreceptor production. Show your work and simplify the resulting function. (1pt)

   c. During what time interval in day 1 will this animal be increasing the number of photopigments it has? (2pts)