Name Period Date

Data Analysis

1. Calculate the mean and median for each of your colors.
2. Write down the highest and lowest value of each color.
3. Write these findings in the data table below.

Period Data

Findings	Red	Yellow	Green	Blue
Mean				
Median				
High				
Low				

Team Data

Findings	Red	Yellow	Green	Blue
Mean				
Median				
High				
Low				

Answer the following questions regarding your data. **Use data from the table to support your answer!**

1. Based on the mean (period and team), which of the colors is the preferred color of the butterflies?

2. Based on the median (period and team), which of the colors is the preferred color of the butterflies?

3. Is/are there any colors that are clearly the least preferred color?

4. What is/are the benefit(s) of using team data over period data?

5. What are some limitations on using the mean or median for determining the food color preference of the butterflies?

6. What could we do in this investigation to ensure that we reduce the variance in our response? (That is, we all had the same data, but many of us counted different totals for each color.)

7. Based on your analysis of the data, write explanatory hypotheses for all colors **except** red. Fill in the blank with "least," "most," or "2nd most"

   Why was green the _____________ preferred?

   Why was yellow the _____________ preferred?

   Why was blue the _____________ preferred?

8. Based on research done by the 7th grade science teachers, we found that blue flowers are not a common choice of butterfly. How does our data from this investigation compare to the teacher's conclusion from reviewing scientific literature?

9. What might this tell us about the findings?

10. Read the following abstracts (summaries) from scientific research done on the *Piers rapae* (cabbage white butterfly).

Lewis, A.C. (1986). Memory constraints and flower choice in *Pieris rapae*. *Science, 232*(4752), pp. 863-865

Darwin hypothesized that flower constancy in insects that feed on nectar results from the need to learn how to extract nectar from a flower of a given species. In laboratory tests, *Pieris rapae*, the cabbage butterfly, showed flower constancy by continuing to visit flower species with which it had experience. The time required by individuals to find the source of nectar in flowers decreased with successive attempts, the performance following a learning curve. Learning to extract nectar from a second species interfered with the ability to extract nectar from the first. Insects that switch species thus experience a cost in time to learn. These results support recent suggestions on the importance of learning in animal foraging.

Lewis, A.C. (1989). Flower visit consistency in *Pieris rapae*, the cabbage butterfly. *Journal of Animal Ecology, 58*(1), pp. 1-13

(1) Animals of several taxa are selective in their diet choices, bypassing potentially rewarding species while foraging. In particular, many nectar and pollen-feeding insects consistently visit flowers of a single species in habitats containing a variety of rewarding species. This study tests this visit consistency in the cabbage butterfly, *Pieris rapae*, freely foraging in a natural environment. (2) Visit consistency, tested by analysis of the likelihood that an encountered flower is the same species as the last flower visited, revealed consistency in visits in non-ovipositing butterflies. (3) Causes of visit consistency are considered. The data give some support to constancy over labile preference. (4) Some of the assumptions under which constancy and labile preference are distinguished appear questionable. A model of preference is presented in which many preference regimes intermediate between constancy and labile preference are possible.

Kandori, I, Yamaki, T., Okuyama, S., Sakamoto, N., Yokoi., T. (2009). Interspecific and inter sexual learning rate differences in four butterfly species. *The Journal of Experimental Biology, 212*, pp. 3810-3816.

Learning plays an important role in food acquisition for a wide range of insects and has been demonstrated to be essential during flower foraging in taxa such as bees, parasitoid wasps, butterflies and moths. However, little attention has been focused on differences in floral cue learning abilities among species and sexes. We examined the associative learning of flower colour with nectar in four butterfly species: *Idea leuconoe, Argyreus hyperbius, Pieris rapae and Lycaena phlaeas*. All butterflies that were trained learned the flower colours associated with food. The flower colour learning rates were significantly higher in *I. leuconoe* and *A. hyperbius* than in *P. rapae* and *L. phlaeas*. Among the four species examined, the larger and longer-lived species exhibited higher learning rates. Furthermore, female butterflies showed a significantly higher learning rate than males. This study provides the first evidence that learning abilities related to floral cues differ among butterfly species. The adaptive significance of superior learning abilities in the larger and longer-lived butterfly species and in females is discussed.

Question continues on next page!

11. These findings all show that the preference of the cabbage white seem to be consistent, even if they could obtain more nectar from another plant. That is, if they learn that a yellow flower has nectar, they will continue to go to yellow plants, regardless if a red flower has more nectar than yellow.

    With these research findings in mind, how might you change your hypotheses about the cabbage white butterfly's color preference?

12. Based on the last article (Kandori et al), what would be the benefit of re-doing our experiment using only male or female butteflies?

13. Based on all that you have learned in this investigation, what scientific question could we attempt to answer next? That is, what can we ask regarding what we found? What additional questions do you have that we could answer through an investigation?