Butterfly Scales Lab Experiment

Teachers' Guide

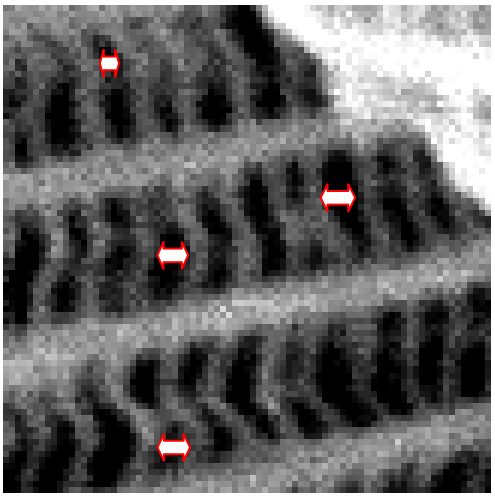
Suggested Grades: 6-12

Objectives:

- Make inferences from observations of phenomena and/or events (S6-3).
- Evaluate conclusions based on scientific data (S6-5).
- Apply concepts of sound and light waves to everyday situations (S9-11).
- Formulate an experimental design to test a given hypothesis (S12-8).
- Collect data, create a table, picture graph, bar graph, circle graph or line graph, and use them to solve application problems (M6-21, M12-5).
- Apply the concept of average and calculate the arithmetic mean (M6-23, M9-14).

Strategies:

- Since butterflies and moths are rare in the winter, you should have students collect several in the fall. Explain to your students that, among other activities, you will be measuring and comparing the colors on their wings. You should discuss the design of the experiment before they gather specimens since you will want to consider which colors you want to collect (black, white, and colors from the rainbow, but not brown) and whether it is better to compare different colors from the same or different specimens.
- It would be wise to introduce the wave-like character of light to your students before this activity. If you need a visual aid, you may use the poster, "How Does Wavelength Change with the Color of Light?" This may be printed in color from your TECH TREK CD using Word.
- Students should collect the data in a table. This data would be presented best by bar or picture graphs.
- Students should discuss how to measure the spacing between the scales. The best way might be to measure the actual openings (gaps) between "rungs." They should measure across the narrow dimension of the spaces, choosing samples randomly.
- Students might hypothesize that the wings with wider spacing will transmit lower energy light such as red. This would be supported if red, yellow, and orange scales have greater spacing than greens, blues, and violets.
- Other students might find a relationship in which the wings with wider spacing absorb lower energy light. This would be supported if the green, blue, and violet wings have wider spacing.
- Another issue to consider is the width of white and black scale spacing. Does this indicate that the colors are due to transmission or absorption?

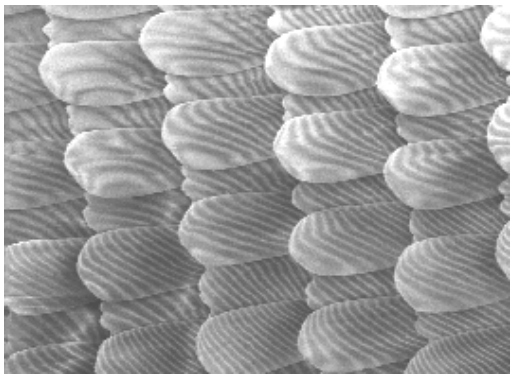


Butterfly Scales

- Your best students should be asked to research this relationship and compare their results with those of other scientists.
- Students may explain their conclusions with sketches of light waves for extra credit.
- Consult with math teachers from your school to decide what types of statistical analysis are appropriate. At the least, students should calculate mean and median for each color scale. Advanced students might plot box and whisker graphs and/or calculate standard deviation.

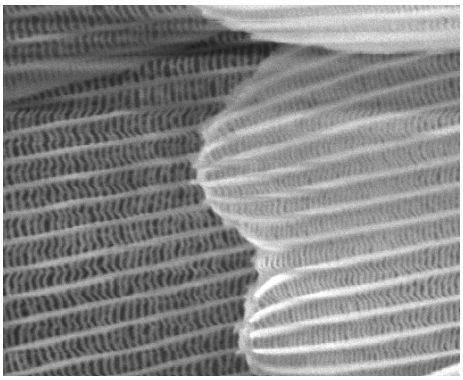
Butterfly Scales Lab Experiment
Name _____

Background: The wings of butterflies and moths are covered with tiny scales of various shapes and textures. Closer inspection reveals spacing patterns. Scientists hypothesize that there is a relationship between the size of the spaces and the colors you see.



Monarch Scales, 100X

100 µm



Monarch Scales, 2400X

10 µm

- What is the relationship between colors and the wavelengths of light? (If necessary, reference the poster, "How Does Wavelength Change with the Color of Light?")

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- What is your hypothesis for the relationship between colors and the size of the spaces on moth and butterfly scales? _____

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Procedure: Carefully prepare a set of slides for the SEM representing a range of colored scales from butterflies and/or moths. Colors from the rainbow are preferred; one black and one white may be included. Label slides carefully. Examine at high magnification under the SEM, taking enough measurements to produce statistical accuracy. Before measuring, decide how to measure consistently and accurately. Analyze your measurements and produce graphical comparisons on paper or computer.

Conclusions: Summarize your results and describe the relationship between spacing size and the colors you see. Compare these results with your hypothesis. What did you learn?

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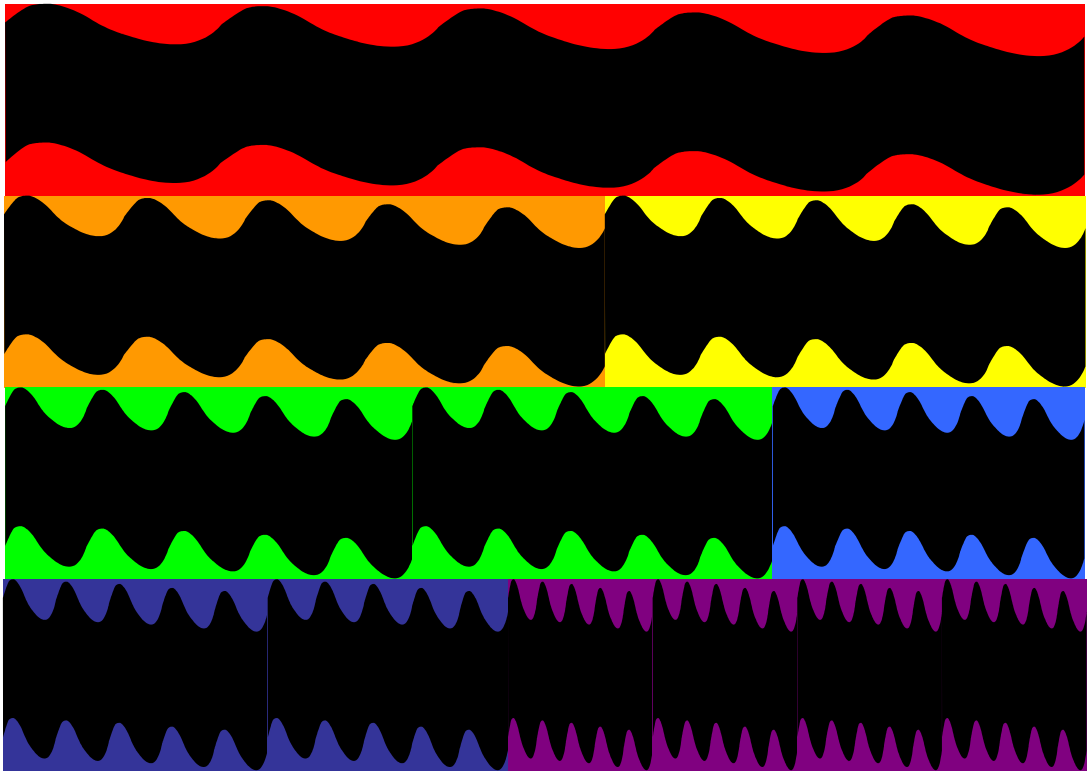
Extra Credit: Sketch and explain the reason(s) for the relationship you discovered.

How Does Wavelength Change with the Color of Light?



NOTE: The scale of these graphics has been exaggerated to help students make this generalization.

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