



# Exploring Color in Nature

**Subject:** Biomimicry

**Grade Level:** 5-8

**Topic:** Color and Pigmentation

**Time:** 60 minutes

## Learning Objectives

Students will:

- investigate the difference between structural color and pigmentation in plants and animals.
- use hands-on experiments to increase their knowledge of plant and animal coloration.
- properly use scientific tools and equipment.

## Materials

Acrylic butterfly cases (we use a custom blue morpho and buttercup display from [butterflyutopia.com](http://butterflyutopia.com)), mini LED flashlights, paper (black and white and bright green) cut into 3” squares, acrylic paint in 2 colors (similar color to interference paint), interference paint in 2 colors (similar colors to acrylic paint. We use red and blue.), paint brushes. *Exploring Structures: Butterflies Document*, *Painting with Structural Color Document*

## Procedure

**Engage:** To promote student curiosity, as a full group, show the students the butterflies in acrylic cases, allowing everyone to look at them. *Ask: What color are the butterflies?* They will likely say blue and yellow.

**Explore:** Help students build understanding by allowing each student to look closely at the butterflies with an LED flashlight. Encourage them to shine the light at the wings from the front and the back.

**Explain:** Have students begin to show what they have learned by having the students to share what they noticed when they looked with their naked eye vs looking with a flashlight shining through the wing. *Ask:*

Why do the colors appear different. Ask: Have you ever seen a car that has color-shifting paint, or a soap bubble, or an oil spill in a parking lot. Ask: What makes those colors shimmer?

Ask: What is the difference between pigment and structural color? **Pigment** is a color added to something that absorbs all colors of light except for the color we see, which is reflected back to our eye. For example, grass appears green because the chlorophyll in the plant absorbs all the colors of the light spectrum EXCEPT for green, which is bounced back off the plant and to our eye. The color of pigment is always visible except in the very dimmest of light.

**Structural Color** is produced by the way light interacts with the texture of the surface. The color is only visible if the light hits it at exactly the right angle. The scales or other surface texture scatter and bend the light causing the sparkly, shimmery, oily, or pearlescent colors we see.

Explain that the blue morpho has structural coloration due to the microscopic, ribbed structures of its scales, while the buttercup butterfly has pigment in its scales.

**Elaborate:** Have students use their new knowledge by having students giving each group 12 squares of colored paper (four of each color). Give each group a bit of each color of interference and acrylic paint, and 4 paint brushes. Keep all paints and brushes separate so as not to mix them up.

Apply a thin coat of each type of paint onto a paper square. Do one type of paint per square. Each type and color of paint should be used on each color of paper. Label each square with what type of paint you used.

Use a dedicated paintbrush for each type of paint. Do not mix them up.

Let the paint dry, then apply another coat. Repeat if desired. Use a blow dryer or air pump to dry the paint quicker.

## Assessment

**Evaluate:** Evaluate student learning by asking students to look at their results and draw conclusions about the different paints. Give each group an LED mini flashlight. Have them shine a bright light on the papers and see if there is any difference. Ask: *What do you notice?* Remind them that interference paint is made up of ONLY structural color, while acrylic paint is made up of ONLY pigment. Ask: *Do the colors ever look the same? What conditions cause any of the colors to appear to change? Why does the interference paint look different than the acrylic paint?*

## Extension Activities

- Discuss how scientists are inspired by the structural color in nature to create new materials and technologies, such as paints, cosmetics, and other products.
- Create Rainbow Bookmarks: Students draw on a bookmark with a silver sharpie marker. The bookmark is submerged in water, and a drop of nail polish is added to the surface. As the nail polish spreads, the

thin film interacts with light, creating a rainbow effect when deposited on the bookmark. This demonstrates how interference in a thin film of liquid can create structural color.

## NGSS Alignment

### Middle School

MS-PS4-2 - Develop and use a model to describe that waves are reflected, absorbed, or transmitted through various materials.

MS-LS1-2 - Develop and use a model to describe the function of a cell part or structure (applied here to wing scale structure and function).

MS-ETS1-1 - Define criteria and constraints of a design problem with sufficient precision (applied in biomimicry discussions and extensions).



Created by the Akron Zoo