Science Fair Log Book 2025-2026

Scarlett Zhong and Rena Feng

November 10 (Scarlett)

What are we doing?

We decided on investigating whether blueberries are truly blue or if their color comes from something other than blue pigment. This will mainly focus on the blueberry's outer waxy coating, or bloom, and how it affects the appearance of a blueberry. Observations will include cutting, juicing, and scrubbing blueberries, testing how light interacts with the bloom, and exploring how structural color works. Moreover, by comparing blueberries with and without bloom, we will also examine differences in color, reflectance, and texture under controlled lighting conditions. If possible, we will look at the components of the bloom up close with a microscope, compare it to other fruits' skins, and analyze how this affects the structural colors. Last, as an extension, we will look at the real pigments(red-ish purple) inside blueberries, called anthocyanins.

Why did we pick this?

Currently, scientists are studying structural color for eco-friendly dyes, better screens, reflective coatings, and more biomimicry designs. We know the blueberry bloom gives blueberries the blue color, but it also acts like a natural protectant. Understanding this can help scientists and farmers know when blueberries are ripe, develop better ways to store fruit, and figure out which fruits need less chemical coatings. Additionally, there are barely any stable, non-toxic blue pigments in the world--which means that this can also inspire people to create and design eco-friendly blue dyes that don't fade. Additionally, we could potentially develop reflective coatings for solar panels, safety gear, and more-- all inspired by this natural wonder.

Questions:

“Think of fruits that are the color blue. Most people will mention the blueberry. But here is the question, "Is it really blue?" The flesh isn't. The pigment in the skin also isn't. We will apply many tests to prove that the fruit is actually not blue.**”**

This will compose of a research section and observation section.

Research Questions:

-How do we see color?

-How does the color blue tie to nature?

-What makes things blue?

-What color is the pigment(s) in the blueberries?

-What is Structural Color?

The tests are yet to be decided. We are going to add tests in between our research to prove the credibility and conduct hands-on experimenting.

November 14-16 (Scarlett and Rena)

Due to inconvenience from the teacher strike, we were only able to finish research these three days.

link to the research doc.

Note that some images were not able to upload.

The sites we used (not in particular order):

YouTube (2018): Why Are Blueberries Blue? —https://www.youtube.com/watch?v=3q246c6Bv58

Seeds (Jun 17 2022): Why is Blue So Rare in Nature?

—https://seeds.ca/schoolfoodgardens/why-is-blue-so-rare-in-nature/

The Kitchn (Jun 8 2016): What's That Waxy Coating on Blueberries?

—https://www.thekitchn.com/whats-that-waxy-coating-on-blueberries-232177

Chelan Ranch (N/A): Why Do Blueberries Look Dusty?

—https://chelanranch.com/blogs/news/why-do-blueberries-look-dusty?srsltid=AfmBOoqCxKrgQLFKBxABHrsw5BbGZ20hPFN8PAoqwl3WnT6EGPia5nKy

Jean Lamantia (Aug 6 2014): What Is That Wax on My Produce?

—https://jeanlamantia.com/what-is-that-wax-on-my-produce/#:~:text=What%20is%20Natural%20Wax?,evenly%20within%20a%20water%20mix.

PubMed Central (Apr 2021): Anthocyanins and Their Effects

—https://pmc.ncbi.nlm.nih.gov/articles/PMC8012384/

ScienceDirect (Apr 2020): Structural Color in Fruits

—https://www.sciencedirect.com/science/article/abs/pii/S0925521419306027

Manoharan Lab, Harvard (N/A): Structural Color —https://www.manoharan.seas.harvard.edu/structural-color

Royal Society of Chemistry (2013): Structural Color in Nature
—https://pubs.rsc.org/en/content/articlelanding/2013/ra/c3ra41096j

ScienceDirect (Dec 2024): Bioinspired Structural Colors
—https://www.sciencedirect.com/science/article/pii/S2772753X24002302

Wiley Online Library (Feb 13 2023): Nanostructure-Based Textiles Inspired by Nature
—https://chemistry-europe.onlinelibrary.wiley.com/doi/10.1002/cmtd.202200081#:~:text=Abstract.based%20textiles%20can%20be%20inspired.

Science.org (Feb 7 2024): Structural Colors in Nature —https://www.science.org/doi/10.1126/sciadv.adk4219

National Wildlife Federation (Jul 19 2012): Bird Vision
—https://www.nwf.org/Magazines/National-Wildlife/2012/AugSept/Animals/Bird-Vision

Nature (Aug 10 2005): Structural Colors in Animals —https://www.nature.com/articles/436791a

Pantone (N/A): How Do We See Color?
—https://www.pantone.com/articles/color-fundamentals/how-do-we-see-color?srsltid=AfmBOopgOcty-yrDkASp5aHF3mRakEIIhDq0v55pKtooHPSTuBN-UpkO

Discover Magazine (May 27 2024): The Color Blue is Relatively Recent for Humans
—https://www.discovermagazine.com/the-color-blue-is-actually-a-relatively-recent-hue-to-humans-46261

Science News (Feb 7 2024): Why Blueberries Are Blue
—https://www.sciencenews.org/article/blueberry-blue-color-nanostructure-wax-pigment

OpenAI (N/A): ChatGPT —https://chatgpt.com/

November 20 (Scarlett and Rena)

We are currently planning the tests:

Test 1: Cutting, juicing, and peeling/rubbing the blueberries to see if there are blue pigments.

Test 2: Sanding and scrubbing the bloom to reveal the actual color of the skin.

Test 3: Testing how structural color works by shining white and UV light on the bloom.

Test 4: Examining the blueberry bloom by comparing the ripeness of the blueberries.

November 23 (Rena)

The procedure:

Test 1: Cutting, Juicing, and Peeling/Scrubbing

1. take a few blueberries from the same container
2. cut one blueberry in half and observe the inside color
3. crush or juice another blueberry and observe the juice color
4. use the peel to scrub on a clean surface
5. observe whether blue color appears or if staining occurs

Test 2: Wax (Bloom) Removal Test

1. select blueberries with visible bloom
2. observe and record their matte blue appearance
3. gently scrub the blueberry surface using sandpaper
4. observe changes in color and texture
5. rub blueberries on oily surfaces (skin, wood, leather, etc.)
6. observe if the bloom is removed and if the berry turns darker

Test 3: Structural Color & Light Test

1. separate blueberries into two groups: with bloom and without bloom
2. shine white light on both groups
3. observe and compare how each group looks (color + shininess)
4. shine UV light on both groups
5. observe how strongly the bloom reflects UV light
6. record observations and differences

Test 4: Ripeness Comparison Test

1. collect blueberries at different ripeness stages
2. observe the amount of bloom on each berry
3. compare the color appearance of fresher vs. older berries
4. note which berries appear more blue or darker

5. record how bloom changes with ripeness

Now our whole idea is complete!

- research how humans see color
    - keywords: human eye anatomy, color wavelengths, how eyes interact with color
- research blue in nature
    - keywords: natural blue vs artificial, blue organisms examples, how something looks blue
- research blueberry structure + pigments
    - keywords: blueberry anatomy, blueberry pigments, anthocyanins, fruit wax
- research structure of bloom (wax layer)
    - keywords: structure of blueberry wax, natural color vs reflection
- research fruit wax types
    - keywords: natural fruit wax vs artificial wax
- research aging + bloom changes
    - keywords: age of blueberries vs color, wax age on blueberries
- research real-world applications
    - structural color in science
    - biomimicry + eco-friendly dyes

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experiment 1: is the inside blue?

materials:

- 6 blueberries
- knife
- blender
- plate

procedure:

- cut blueberries in half

- observe inside color
- crush some + observe juice
- rub peel on surface
- check for blue staining

experiment 2: does the bloom affect color?

materials:

- 6 blueberries
- sandpaper
- oily surfaces (skin, wood, leather)

procedure:

- select blueberries with visible bloom
- scrub bloom off using sandpaper
- rub bloom on oily surfaces
- compare appearance before vs after

experiment 3: light test (structural color test)

materials:

- 2 blueberries (one with bloom, one without)
- UV light
- white light

procedure:

- separate into bloom vs no bloom
- shine white light
- shine UV light
- compare appearance

experiment 4: aging comparison

materials:

- fresh blueberries
- 3-day-old blueberries
- 5-day-old blueberries

procedure:

- compare color + bloom amount
- analyze changes with age

December 12 (Scarlett and Rena)

We have done the tests..

Here are our observations(will upload pictures later):

Test 1 Observations: Cutting, Juicing, and Peeling/Scrubbing

- When blueberries were cut open, the inside was not blue and looked more dark purple/clear
- Juicing the blueberries gave a dark purple/black juice, not blue
- Scrubbing the peel did not release blue pigment—the juice stained surfaces are red-ish purple

Test 2 Observations: Wax (Bloom) Removal Test

- Blueberries with bloom had a matte, dusty blue appearance
- Scrubbing with sandpaper and rubbing on oily surfaces removed the wax and made the berry look black and glossy

Test 3 Observations: Structural Color & Light Test

- Under white light, blueberries with bloom appeared blue and matte
- Blueberries without bloom appeared black and shiny
- Under UV light, the bloom reflected UV light strongly

Test 4 Observations: Ripeness Comparison

- Less ripe/fresher blueberries had more visible bloom and looked more blue
- Older or overripe blueberries often lost their bloom
- Blueberries without bloom appeared darker and less blue

We are currently working on writing our method and researching out in a desirable format.

December 21 (Scarlett)

We have revised everything, and finished our application. Still working on analysis and conclusion.

Application to Adaptation:

Humans have cone cells that respond to red, green, and blue light. Birds are extremely sensitive to blue, purple, and ultraviolet—and blueberries don't just emit a blue light, there are also purple and ultraviolet light present—which is the prime color blueberries want to emit to attract birds. This is a blueberry's adaptation to its surroundings in order to spread.

Application to Real World:

Currently, scientists are studying structural color for eco-friendly dyes, better screens, reflective coatings, and more biomimicry designs. We know the blueberry bloom gives blueberries the blue color, but it also acts like a natural protectant. Understanding this can help scientists and farmers know when blueberries are ripe, develop better ways to store fruit, and figure out which fruits need less chemical coatings. Additionally, there are barely any stable, non-toxic blue pigments in the world--which means that this can also inspire people to create and design eco-friendly blue dyes that don't fade. Additionally, we could potentially develop reflective coatings for solar panels, safety gear, and more-- all inspired by this natural wonder.

The blue colored dye is extremely hard to make. This is because there is rarely anything in nature that isn't blue from structural color. This made natural blue dyes—like ultramarine(from lapis)— really expensive. Synthetic blue came later, but it is still not stable and eco-friendly enough. Other colors are pretty common, like red, orange, black, and white. However, yellow can be hard to make that isn't toxic to us humans. Moreover, purple is also extremely rare and inconsistent, which makes it also very expensive. Plants can make purple from anthocyanins, but the color is unstable. It can shift with pH and fade very quickly.

We have also copied our work onto the cysf platform, finishing our research. FYI we were able to successfully upload the images onto the platform, unlike in the document.

December 22 (Scarlett)

The analysis/data is done:

Test 1: Cutting, Juicing, and Peeling/Scrubbing

- *The inside of blueberries and the juice are not blue, so the blue color we see on the outside isn't from pigment inside.*
- *The fact that scrubbing the peel doesn't release blue pigment shows the color is not a dye, it's something on the surface.*
- *Thus, the blue comes from the surface, not juice pigment.*

	Cutting Blueberries	***Juicing Blueberries***	***Scrubbing Peel of the Blueberries***
Blue or not?	*No. Appears white, a little red-ish purple.*	*No. Juice is completely purple with a little red.*	*No. The stain is red, maybe purple-ish.*

Test 2: Wax (Bloom) Removal Test

- *Removing the wax (bloom) made the berries look black and glossy, showing the blue appearance depends on the wax coating. Is the wax blue?*
- *Rubbing on oily surfaces removes bloom, but we cannot see the wax, meaning it's transparent.*
- *This means that the bloom is key to the blueberry looking blue; it filters the light wavelengths.*

Test 3: Structural Color & Light Test

- *Berries with bloom look blue and matte under white light; without bloom, they look black and shiny.*
- *Bloom reflects UV light strongly, which is probably the evolutionary reason we have bloom such that birds can spot them easily.*
- *The blue color comes from structural color, not pigment. The wax creates a microscopic surface that absorbs and reflects light.*

Test 4: Ripeness Comparison Test

- *Older blueberries often lose their bloom and appear darker, meaning they get less blue.*
- *Fresher blueberries with more bloom appear more blue.*

- *This further supports our theory that bloom affects the blue color.*

The conclusion is done.

> *"We will investigate whether blueberries are truly blue or if their color comes from something other than blue pigment. This will mainly focus on the blueberry's outer waxy coating, or bloom, and how it affects the appearance of a blueberry. Observations will include cutting, juicing, and scrubbing blueberries, testing how light interacts with the bloom, and exploring how structural color works. Moreover, by comparing blueberries with and without bloom, we will also examine differences in color, reflectance, and texture under controlled lighting conditions. If possible, we will look at the components of the bloom up close with a microscope, compare it to other fruits' skins, and analyze how this affects the structural colors. Last, as an extension, we will look at the real pigments(red-ish purple) inside blueberries, called anthocyanins."*
>
> *"Testable Question: If blueberries don't contain blue pigments, then what gives them their vibrant blue appearance?*
>
> *Hypothesis: If the bloom that makes a blueberry blue is taken off, then it will lose its blue appearance and show the true purple/black pigment underneath, because the bloom creates structural color while the pigments inside the skin are red/purple anthocyanins—which are not blue."*

After everything, we are firm that blueberries aren't truly blue—the color comes from the wax on their surface, or bloom, and not from the pigments. We learned that the bloom reflects and absorbs light wavelengths such that the berry looks blue to humans and reflects UV light that birds can see. This color produced is called structural color, and many organisms in nature use this method to attract mates, spread seeds, ect. Moreover, this proves that our hypothesis was indeed correct. Moreover, the blueberry pigments can only appear to be between either red, purple, or blue. This is called Anthocyanins. The reason the Anthocyanins aren't named a truly blue pigment is because it is extremely unstable and can change color under different pH levels.

- *After conducting multiple tests like slicing, juicing, and rubbing the blueberry, we realized that the blueberry doesn't contain blue pigments;*
- *After scrubbing the blueberry on sandpaper and oily surfaces such that no bloom exists, we examined that the bloom doesn't leave behind pigments either;*
- *After examining the reflection of the bloom under UV light compared to the plain skin, it proves that blueberries seem blue because of the bloom;*
- *After comparing the blueberry blooms of fresh and old blueberries, we see that the blueberries seem more blue when there are more wax present. This further stabilizes our theory.*

Understanding this can inspire eco-friendly blue dyes, reflective coatings, and biomimicry designs, because natural blue pigments are super rare and hard to make.

We are now only missing the acknowledgement of errors and presentation/trifold.

Edit: have uploaded all to cysf platform

January 29 (Scarlett)

Final check-in, we are done everything and finished the trifold. We couldn't conduct multiple tests due to the teacher strike, but overall the results were satisfactory.