Wisconsin Fast Plants and CODAP

Using Fast Plants observations and data analysis to investigate variation & how traits are inherited

CAROLINA®

The Concord Consortium

WISCONSIN FAST PLANTS®

What we plan for you to take away from this webinar includes the following:

- An easy to use Fast Plants technique for teaching genetics without needing any planting materials or high intensity lights.
- A Complete Fast Plants investigation that we co-designed to align with secondary NGSS inheritance standards (middle or high school level) and support Three Dimensional learning.
- An introduction to using CODAP, a free, browser-based data tool that animates data during analysis, illustrating what happens when we look for patterns and then use logic to make sense of those patterns.

Brief intro to the webinar facilitators

Carolina: Julie Stubbs Product Manager for Zoology, Botany, and Microbiology

Wisconsin Fast Plants Program, University of Wisconsin-Madison: Hedi Baxter Lauffer, Director of Teaching and Learning

Concord Consortium: William Finzer, Senior Scientist

Concord Consortium: Frieda Reichsman, Senior Research Scientist

Introduction to the Phenomenon

- How can these vegetables we commonly see at the grocery store be part of the same plant family, yet look so different?

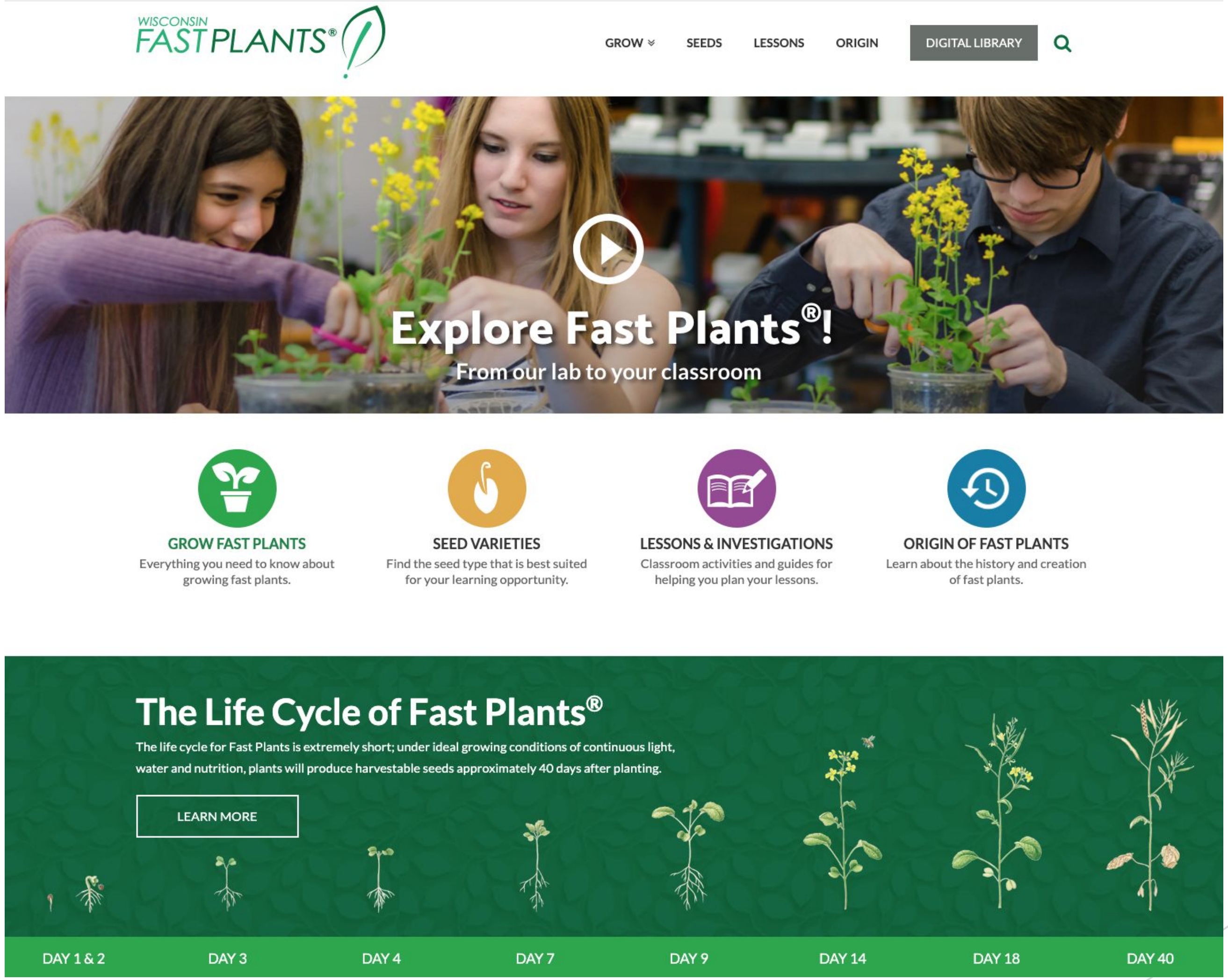
Investigation Overview

Wisconsin Fast Plants are used as a model organism to investigate variation similar to what we see in grocery store *Brassicas*.

Select genetic stocks of Fast Plants have easily observable traits that have dominant/recessive inheritance patterns just like those that Mendel observed in peas.

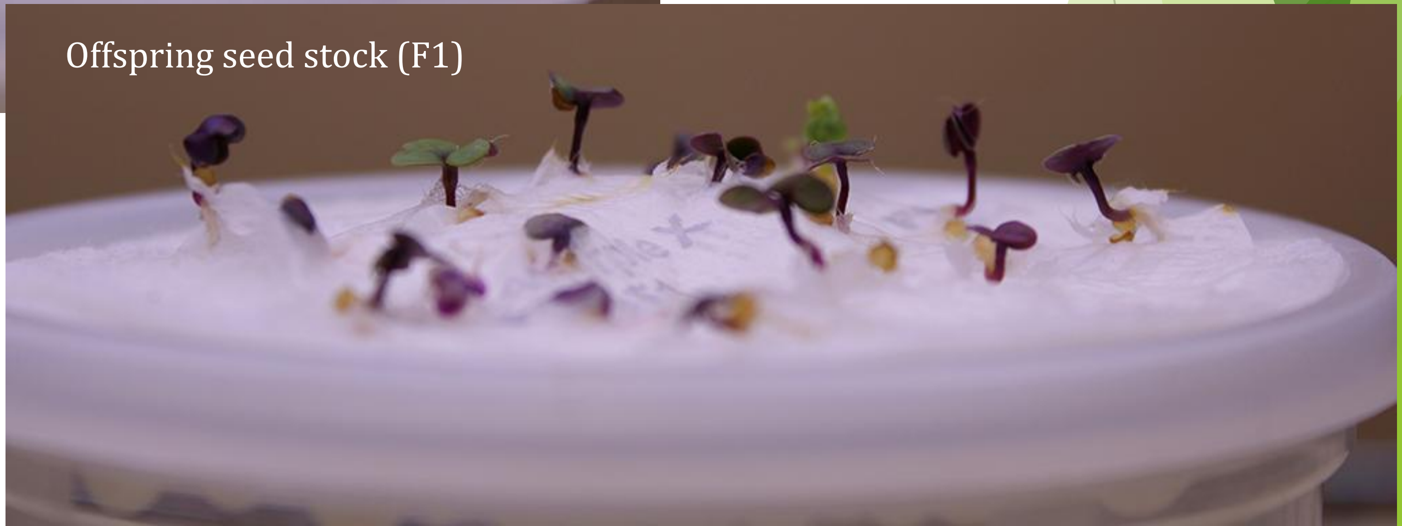
This investigation uses Fast Plants seed disks without soil or special lighting

Lots of information & lessons: www.fastplants.org

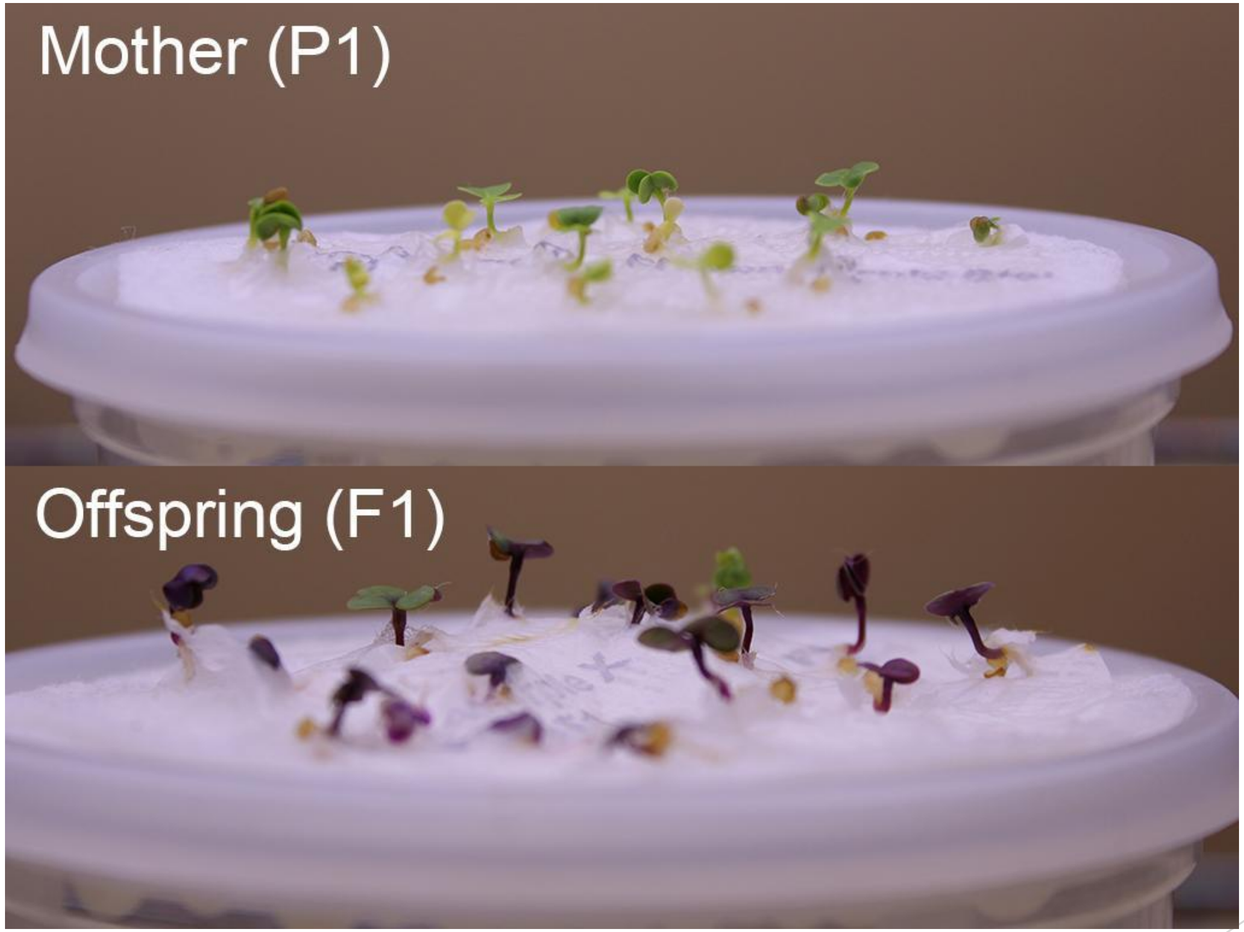


Just add water seed disks, then look for variation in seedlings in about 72 hours.

What do you notice about these two groups of Fast Plants?



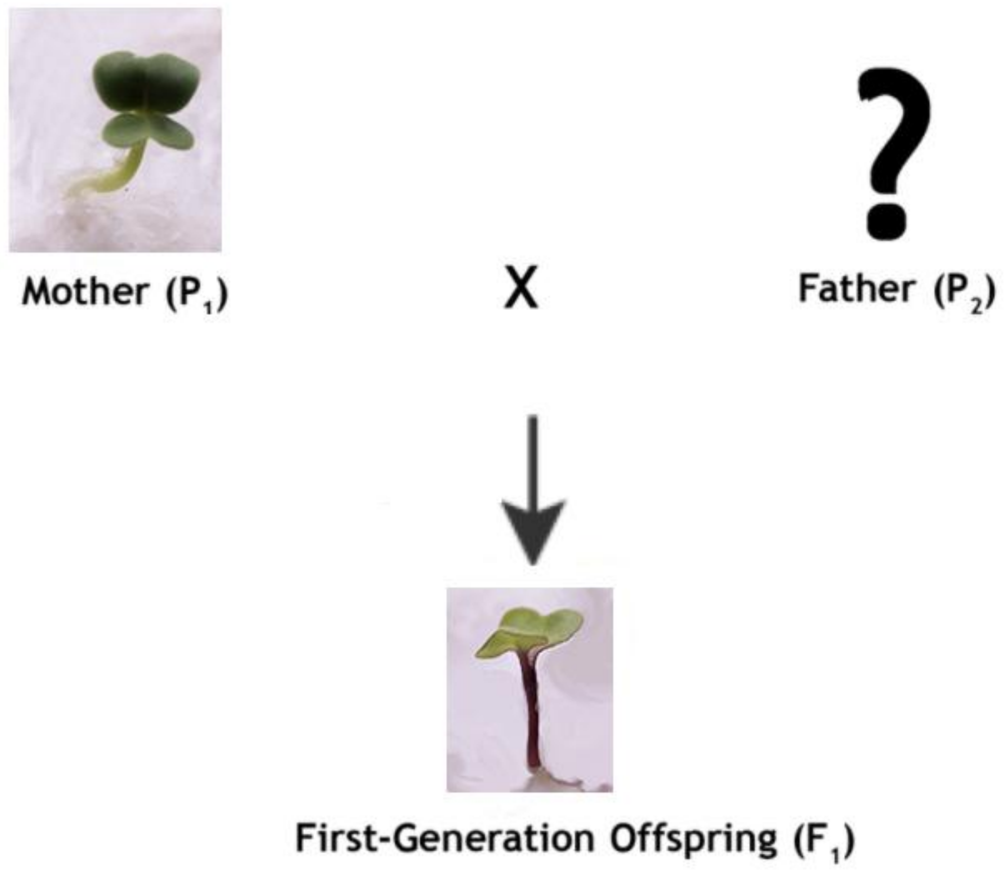
Students develop questions to investigate what underlying processes could cause the stem color variation they observe firsthand.



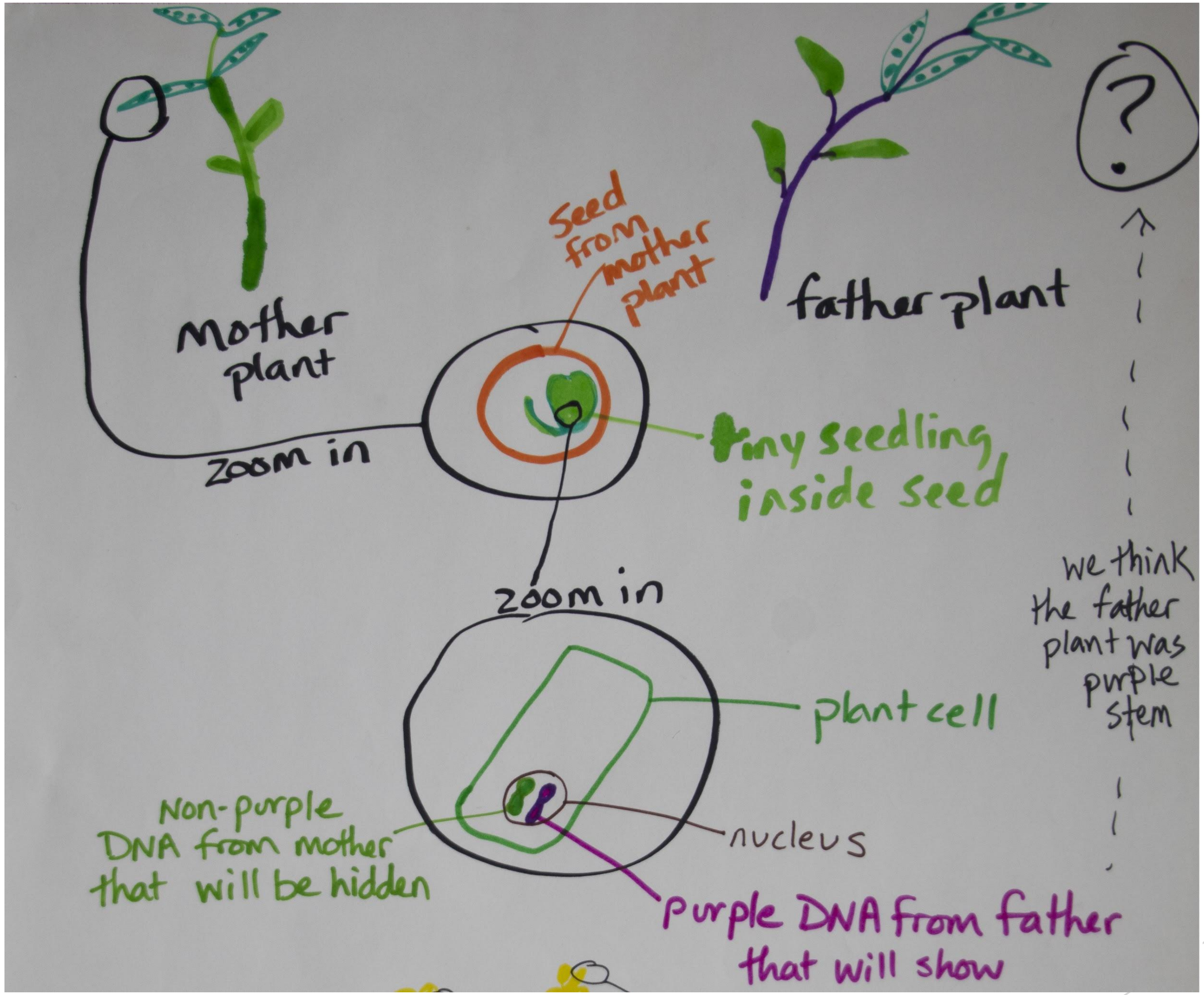
Investigation Overview

1. Wisconsin Fast Plants are used as a model organism.
2. Students develop models (diagrams) that explain their thinking about why all the offspring an look different than the mother.

What students know, so far...



Sample models we have seen from students



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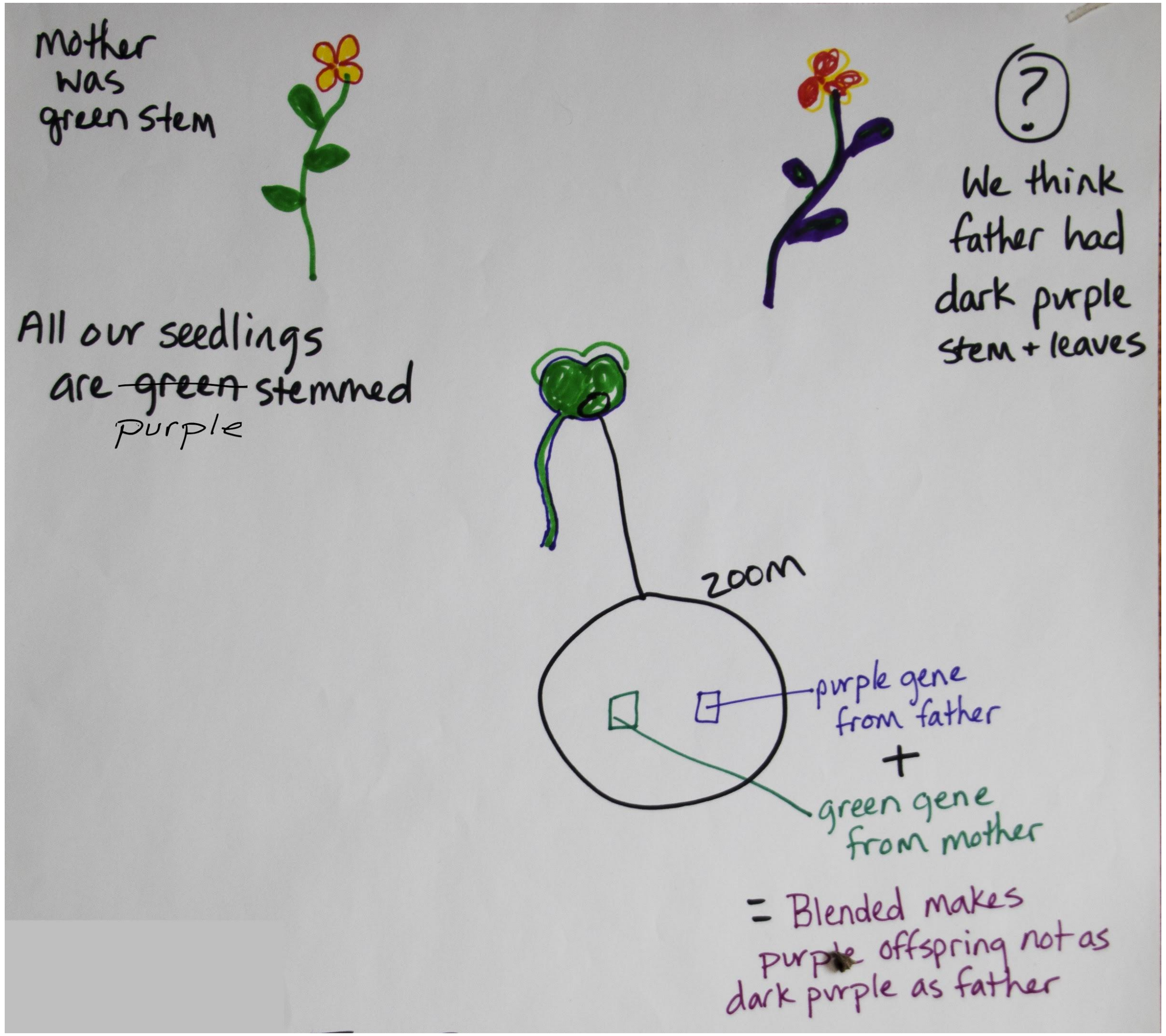
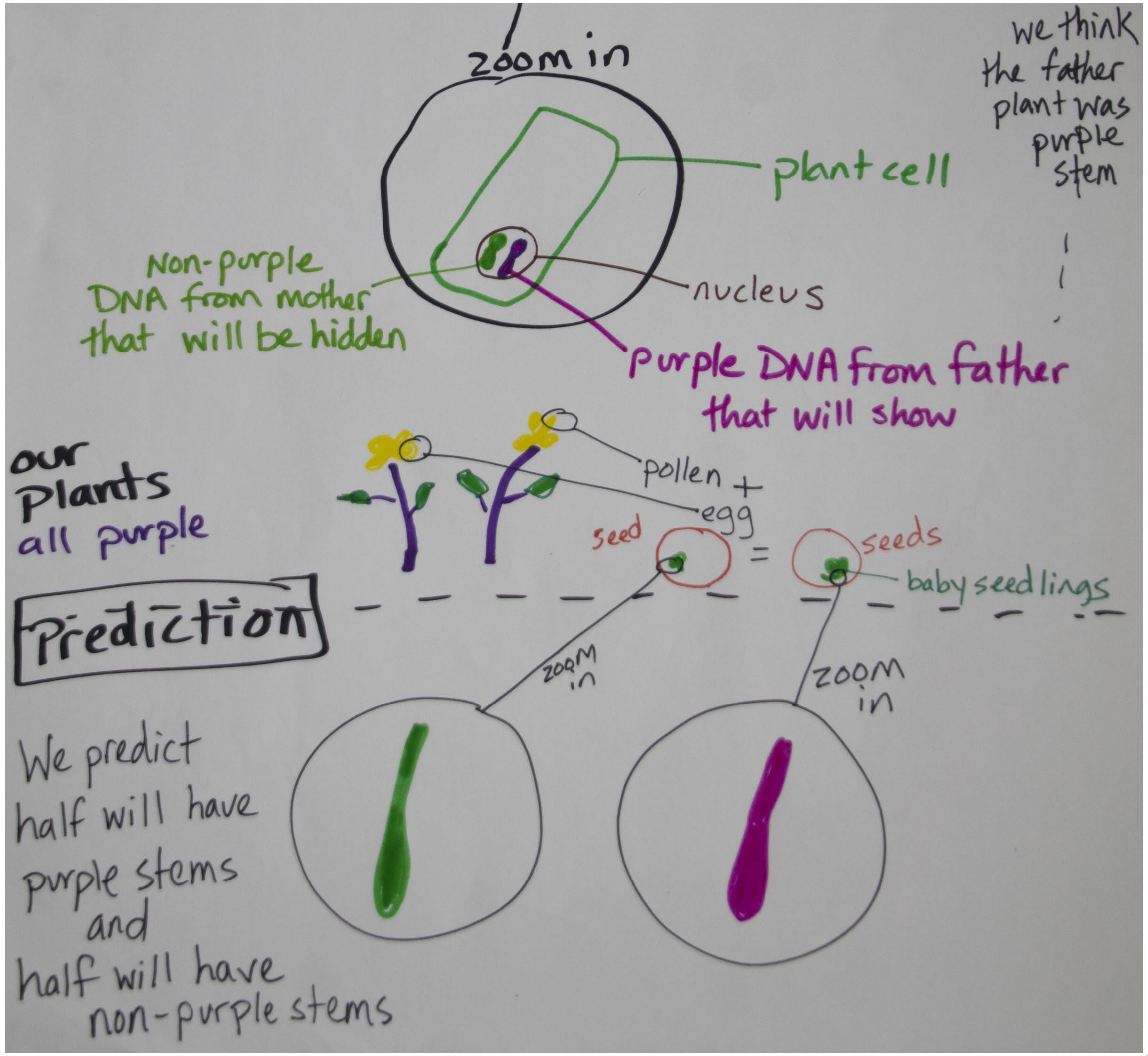


Investigation Overview

1. Wisconsin Fast Plants are used as a model organism.
2. Students develop models (diagrams) that explain their thinking about why all the offspring look different than the mother.
3. Students use their models to predict what will happen if their Purple stem offspring generation are all intermated to produce a second offspring generation.

This sample model predicts F2 generation will have 50% green and 50% purple stems

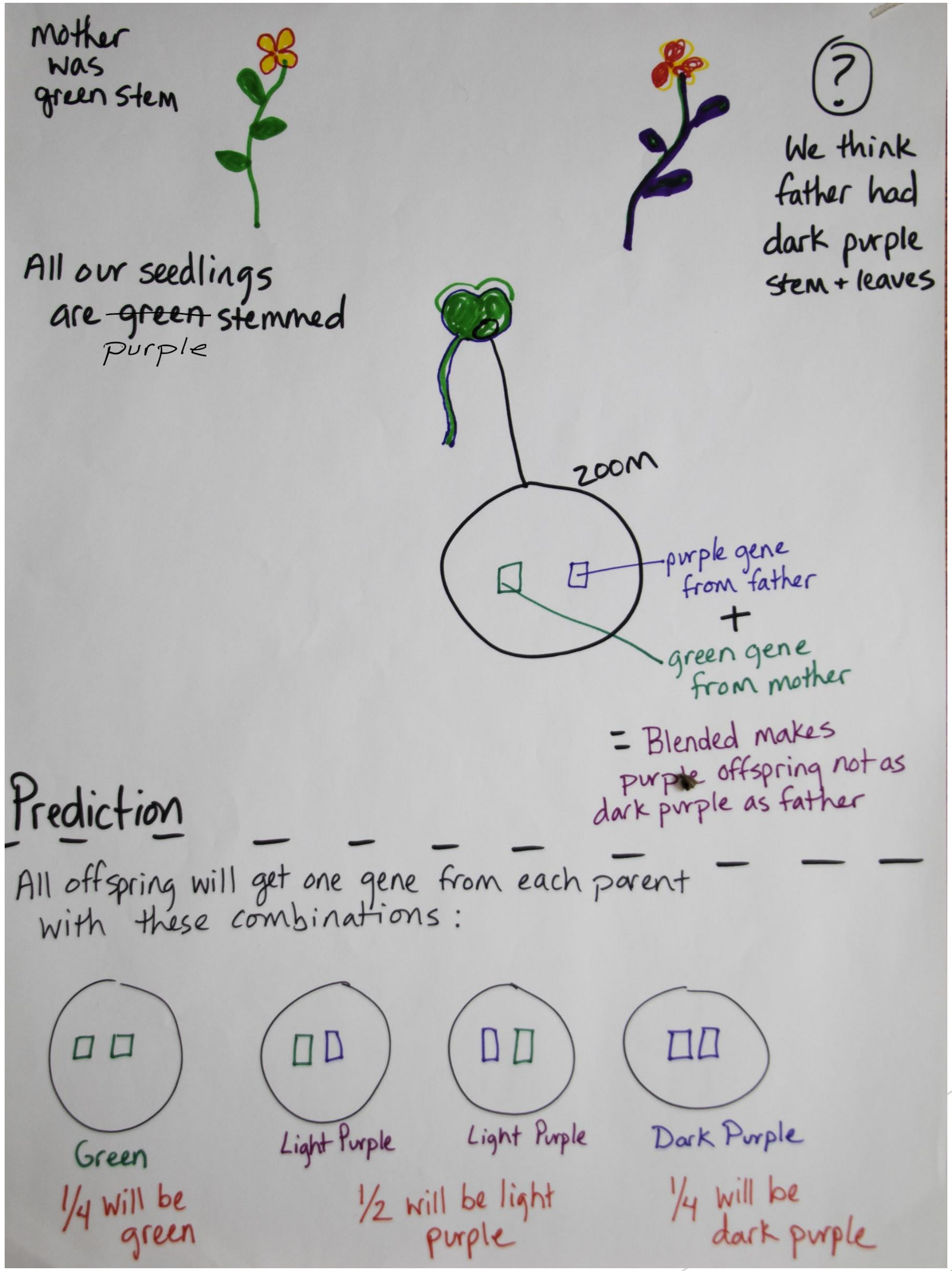


This sample model predicts the F2 generation will have:

25% green

50% light purple

25% dark purple

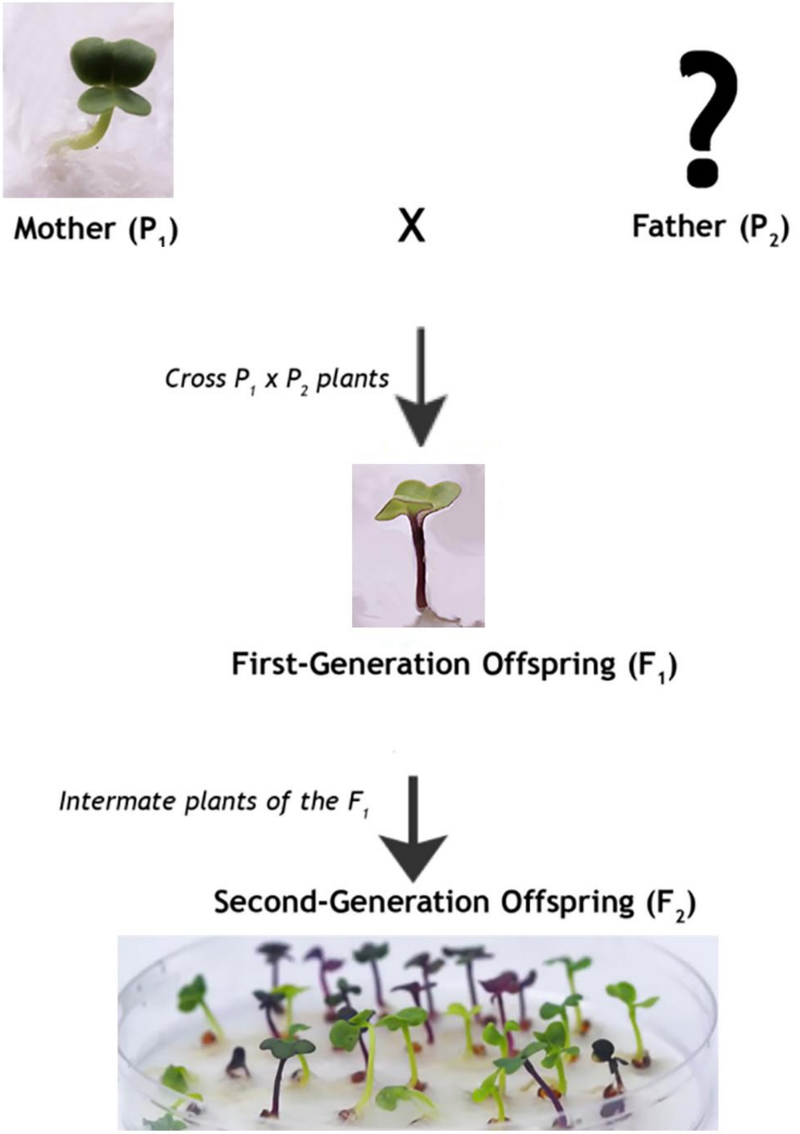


Using second offspring generation seeds already prepared in the seed disk set...

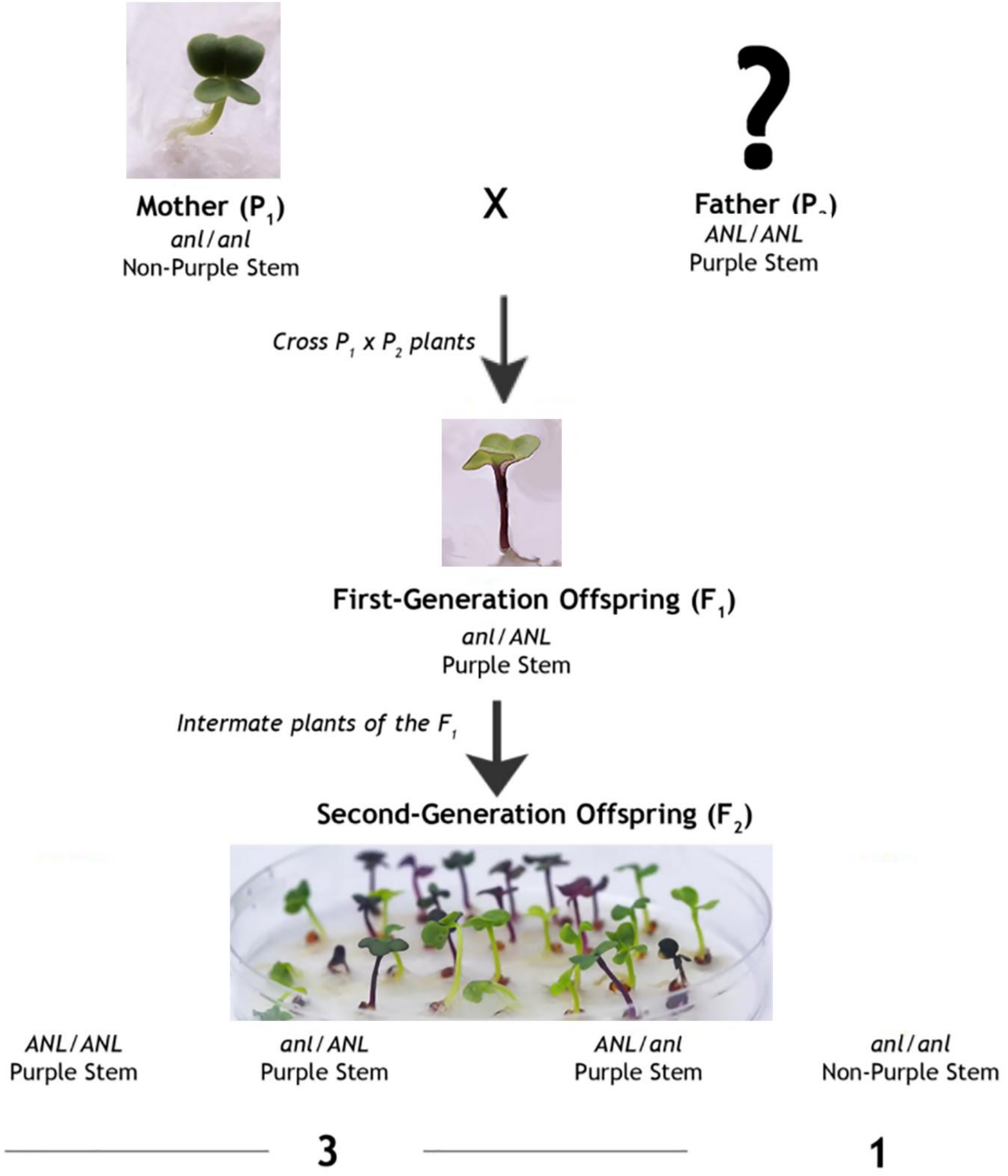
How many purple stem and how many green stem seedlings do you count?

How will we know if the F2 offspring results support or refute what the models predicted?

Students used their models to predict stem color ratios in the second generation offspring



We know as teachers to expect a Mendelian inheritance pattern.



Investigation Overview

1. Wisconsin Fast Plants are used as a model organism.
2. Students develop models.
3. Students use their models to predict what will happen if their Purple stem offspring generation are all intermated to produce a second offspring generation.
4. Data collected in small groups from the F2 generation is analyzed and compared to model predictions.
5. Data from all groups is combined, analyzed, compared to small group data and models.

Data collection, entry, and analysis

Data entry for Fast Plants

Group info (1 cases)

index	Student Group ID	Class_ID
1		A

Plants (25 cases)

index	Plant Number	Purple
1	1	yes
2	2	no
3	3	
4	4	
5	5	
6	6	
7	7	
8	8	
9	9	
10	10	
11	11	
12	12	
13	13	
14	14	
15	15	
16	16	
17	17	
18	18	

CODAP

Time for CODAP to analyze & figure out if observed data supports or refutes our models!

The Common Online Data Analysis Platform

CODAP

codap.concord.org

CODAP

- A free data exploration environment that runs in a browser with no installation or login
- Designed for classroom learning (grades 5–14)
- Datasets, help, tutorials

Data collection, entry, and analysis

Data entry for Fast Plants

Group info (1 cases)

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Plants (25 cases)

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8	8	
9	9	
10	10	
11	11	
12	12	
13	13	
14	14	
15	15	
16	16	
17	17	
18	18	

CODAP document for data entry

codap.concord.org/releases/latest/#shared=151550

CODAP document with sample data for 10 groups

codap.concord.org/releases/latest/#shared=151566

Investigation Flow Review

1. Students observe P1 & F1 plants, and develop an initial model.

2. Students use their models to predict the outcome for the F2 generation.

3. Students observe the F2 plants in small groups, use CODAP to analyze their data, and revise their initial model.

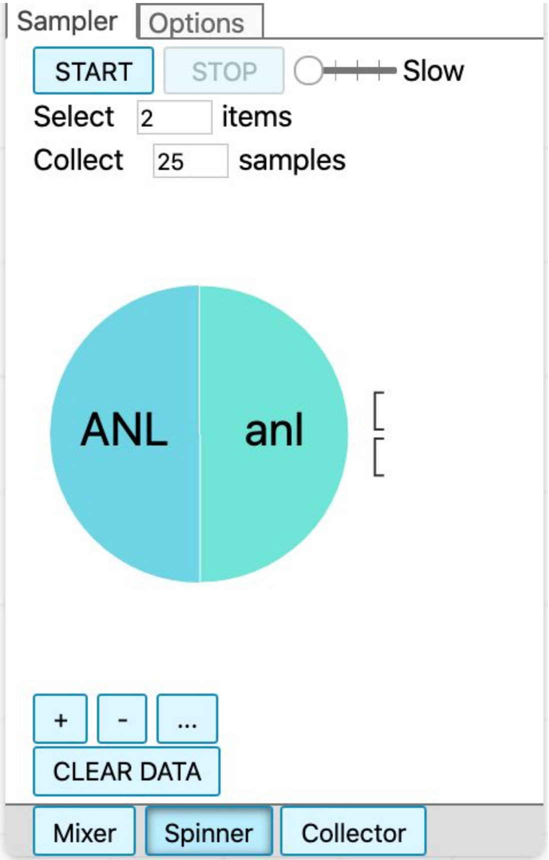
4. Students combine F2 data as a class, and use CODAP to analyze the larger data set, then revisit their models.

5. Students learn about the underlying causes (alleles) for Non-purple stem Fast Plants and gamete production (as needed).

6. Students use CODAP simulation to analyze F2 results and finalize an accurate class-consensus model.

CODAP Simulation of offspring of heterozygous parents

Simulation document: codap.concord.org/releases/latest/#shared=152897



Aligned Performance Expectations

Students who demonstrate understanding can:

MS-LS3-1. **Develop and use a model to describe why structural changes to genes (mutations) located on chromosomes may affect proteins and may result in harmful, beneficial, or neutral effects to the structure and function of the organism.** [Clarification Statement: Emphasis is on conceptual understanding that changes in genetic material may result in making different proteins.] [*Assessment Boundary: Assessment does not include specific changes at the molecular level, mechanisms for protein synthesis, or specific types of mutations.*]

HS-LS3-1. **Ask questions to clarify relationships about the role of DNA and chromosomes in coding the instructions for characteristic traits passed from parents to offspring.** [Assessment Boundary: Assessment does not include the phases of meiosis or the biochemical mechanism of specific steps in the process.]

The performance expectation above was developed using the following elements from the NRC document *A Framework for K-12 Science Education*:

Science and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
Developing and Using Models Modeling in 6–8 builds on K–5 experiences and progresses to developing, using, and revising models to describe, test, and predict more abstract phenomena and design systems. • Develop and use a model to describe phenomena. **Analyzing and Interpreting Data** Analyzing data in 3–5 builds on K–2 experiences and progresses to introducing quantitative approaches to collecting data and conducting multiple trials of qualitative observations. When possible and feasible, digital tools should be used. • Analyze and interpret data to make sense of phenomena using logical reasoning. **Using Mathematics and Computational Thinking** Mathematical and computational thinking in 6–8 builds on K–5 experiences and progresses to identifying patterns in large data sets and using mathematical concepts to support explanations and arguments. • Use mathematical representations to support scientific conclusions and design solutions. **Engaging in Argument from Evidence** Engaging in argument from evidence in 6–8 builds on K–5 experiences and progresses to constructing a convincing argument that supports or refutes claims for either explanations or solutions about the natural and designed world(s). • Use an oral and written argument supported by evidence to support or refute an explanation or a model for a phenomenon.	**LS3.A: Inheritance of Traits** • Genes are located in the chromosomes of cells, with each chromosome pair containing two variants of each of many distinct genes. Each distinct gene chiefly controls the production of specific proteins, which in turn affects the traits of the individual. Changes (mutations) to genes can result in changes to proteins, which can affect the structures and functions of the organism and thereby change traits. **LS3.B: Variation of Traits** • In addition to variations that arise from sexual reproduction, genetic information can be altered because of mutations. Though rare, mutations may result in changes to the structure and function of proteins. Some changes are beneficial, others harmful, and some neutral to the organism. **LS3.A: Inheritance of Traits** • Each chromosome consists of a single very long DNA molecule, and each gene on the chromosome is a particular segment of that DNA. The instructions for forming species' characteristics are carried in DNA. All cells in an organism have the same genetic content, but the genes used (expressed) by the cell may be regulated in different ways. Not all DNA codes for a protein; some segments of DNA are involved in regulatory or structural functions, and some have no as-yet known function.	**Cause and Effect** • Empirical evidence is required to differentiate between cause and correlation and make claims about specific causes and effects. **Patterns** • Patterns in the natural and human designed world can be observed, used to describe phenomena, and used as evidence. (1-LS3-1) **Systems and System Models** • Models (e.g., physical, mathematical, computer models) can be used to simulate systems and interactions—including energy, matter, and information flows—within and between systems at different scales.

If you want to try this with your students:

Item #:158940 at carolina.com

Molecular analysis can also be used to bridge the observed phenotype to the underlying genotype.

Item #211461:at carolina.com

Students' models and explanations for inheritance patterns connect back to the original phenomenon

- How can these vegetables we commonly see at the grocery store be part of the same plant family, yet look so different?

Thank you for joining us!

- Thanks to you all, we’ve just completed this first in a series of webinars about using Fast Plants and CODAP together to create powerful, Three Dimensional learning experiences.
- We’re planning our next webinar for the start of fall semester with a focus on a Fast Plants selection investigation for teaching natural selection concepts in Three Dimensions.
- Following a brief survey, you’ll receive a link to a complete set of teaching materials for facilitating this investigation.

Q&A What questions do you have for us?