Plant Paternity Test

Heredity Investigation

Edgenuity Unit: Heredity Lesson: Laws of Inheritance

Time: 7 weeks ~ 45 minutes per week

Learning Target

I can explain the inheritance of a trait in Fast Plants.

Materials

- Wisconsin Fast Plant seeds
  - Non-purple stem (P_1)
  - Purple stem (P_2)
  - F_1 non-purple stem
- 4 deli container growing systems
  - 16 oz deli container
  - 8 oz deli container
  - Wicking cord or string
- Light box – growing house
  - 2 crates
  - Aluminum foil
  - Hanging light fixture
  - 24 watt CFL
- Potting soil
- Wisconsin Fast Plant fertilizer
- Labels
- Q-tips

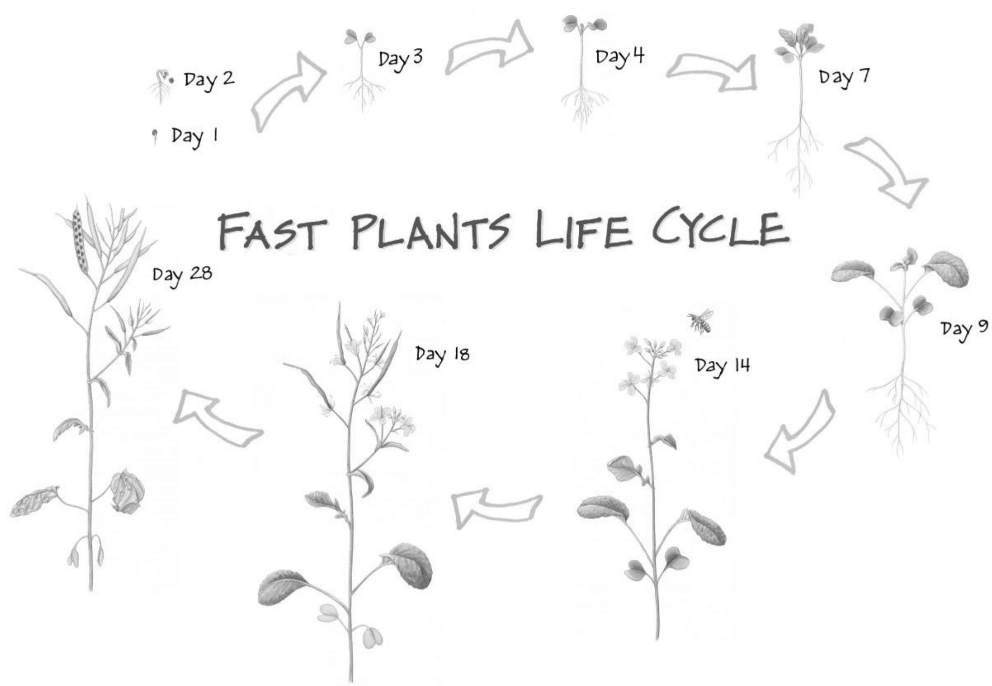
<u>Genes</u>

Every cell in plants and animals contains DNA that is made up of thousands of **genes**. Every cell (except **gametes**) has two copies of each **gene** (one from each parent) and the two sets of **genes** are different from each other. Cells with two copies of **genes** are called **diploid**. During **meiosis**, each **gene** pair is spilt apart randomly so that the resulting **gametes** (eggs or sperm/pollen) have a single copy of reassorted **genes**. Cells that have only one set of **genes** are called **haploid**. During mating, two parents each contribute a single **gamete**. The two **gametes** fuse and create a single **diploid** offspring.

<u>Alleles</u>

Each **gene** can have a different form, called an **allele**. Different **alleles** are represented by the same letter, but coded by capitalization. **Dominant alleles** are capitalized and **recessive alleles** are lower case (e.g. Pp). The interaction of paired **alleles**, along with environment, determines the **phenotype** (the **gene's** expression) of the offspring. **Recessive alleles** are expressed when paired with another **recessive allele** (pp).

This activity will investigate a purple pigment found in many plants, Anthocyanin (anl), and how the **gene** is passed from parents to offspring. It is best observed when plants are between 4 and 7 days old. You will be testing the **inheritance** of a specific trait by growing Fast Plants for two generations.



<u>Procedure:</u>

<u>Day 0</u>

1. Plant the seeds from the mother plants (P_1) in 1 container and plant seeds from first generation (F_1) in 3 containers using the following directions:
2. Poke a hole in the center of the bottom of the 8 oz. deli container.
3. Cut a wick 12-14 cm long, wet thoroughly with water and insert 2 cm into the bottom of 8 oz deli container.
4. Pour ¼ cup (2 oz.) of soil into the 8 oz. container.

5. Spread 18 pellets of fertilizer evenly on top of the soil.
6. Add ½ (4 oz.) cup of soil on top of fertilizer pellets.
7. Sprinkle water over soil until it is dripping from the wick.
8. Label containers based on the seeds that were planted.
9. Place 5 seeds in a circle pattern on top of the soil.
10. Cover seeds with ¼ cup of soil.
11. Pour 1 cup (8 oz.) of water into the 16 oz. deli container.
12. Set the small container on top of the larger container.
13. Place in light box and cover front (the plants will need plenty of water and 24 hours of light!)

Days 4-7

1. Observe the stem and leaf color of the young P_1 and F_1 plants.
2. Record the number of individuals with each trait in the table below.

List each phenotype	Purple stem	Green stem	Purple leaf	Green leaf
P_1 generation				
F_1 generation				

3. Discard the P_1 plants but continue to maintain the F_1 plants.
4. Thin F_1 plants to 2 per container.
5. Explain how you think stem and leaf colors are inherited in Fast Plants.

6. Predict the father's (P_2) stem and leaf colors based on your explanation.

Days 15-17

1. Pollinate the entire **population** of F_1 plants for 3 days. Use Q-tips to spread pollen from one flower to another. Make sure all flowers receive pollen from more than one plant.

   Fast Plants require outcrossing to reproduce. This can happen in the wild with help from pollinators (like bees) or can be aided by wind.

2. Based on your **hypothesis**, predict the stem color of the second-generation offspring (F_2) that will result from the pollination you did today.

Day 18

1. Cut off any new flower buds that were not pollinated on previous days

Day 37

1. Stop watering plants. Let them dry out for a full week

Day 44

1. Harvest the seeds from the F_1 plants (these will be the F_2 seeds)
2. Place the F_2 seeds in a manila envelope and label them
3. Remove plants from the first generation and clean deli containers and dry (so they can be reused the next day)

Day 45

1. Plant the F_2 seeds following the growing directions from Day 0

Day 49

1. Observe the stem color of the young F_2 plants

2. Record the number of individuals with each trait in the table below

List each phenotype	Purple stem	Green stem	Purple leaf	Green leaf
F_2 generation				

3. Put your claims to the test! Was the ratio of the phenotypes in the F2 generation what you predicted it would be? Was it even close?

A χ^2 (chi-squared) test will compare your observations with your **hypothesis**.

$$\chi^2 = \sum \frac{(\text{Observed frequency} - \text{Expected frequency})^2}{\text{Expected frequency}}$$

Chi-square is a statistical test commonly used to compare observed data with data we would expect to obtain according to a specific **hypothesis**. For example, if, according to Mendel's laws, you expected 10 of 20 offspring from a cross to be male and the actual observed number was 8 males, then you might want to know about the "goodness to fit" between the observed and expected. Were the deviations (differences between observed and expected) the result of chance, or were they due to other factors. How much deviation can occur before you, the investigator, must conclude that something other than chance is at work, causing the observed to differ from the expected. The chi-square test is always testing what scientists call the **null hypothesis**, which states that there is no significant difference between the expected and observed result.

Step 1. What is your **null hypothesis**?

Step 2- Determine the ratio of **phenotypes** you expected in the F2 generation, based on your **hypothesis**.

Phenotype	Expected Number of Plants (e)
1. ____purple stem_________	__________________
2. ____green stem__________	__________________
3. ____purple leaf___________	__________________
4. ____green leaf____________	__________________

Step 3 - Record the ratio of **phenotypes** you observed in the F2 generation.

Phenotype	Observed Number of Plants (o)
1. ____purple stem_________	__________________
2. ____green stem__________	__________________
3. ____purple leaf__________	__________________
4. ____green leaf___________	__________________

Step 4 - Fill out the following table. Note: For o and e values, use the actual numbers of plants, not percentages or ratios.

List Each Phenotype:	1	2	3	4
Observed value (o)				
Expected value (e)				
Deviation (d) = o-e				
Deviation squared (d^2)				
d^2/e				

Add all of the d^2/e values together to get the χ2 value.

$$X^2 = \Sigma \frac{(\text{Observed frequency} - \text{Expected frequency})^2}{\text{Expected frequency}}$$

Step 5 Calculate the degrees of freedom by subtracting one from the number of **phenotypes**.
degrees of freedom = (Number of **phenotypes** possible) – 1

Step 6 Determine whether to accept or reject your **hypothesis**. Find the probability that the deviation of the observed values from the expected values was a chance occurrence. Look up your degrees of freedom in the table below. Find where your χ2 value falls in that row.

Degrees of Freedom	Probability of Chance Occurrence								
	90%	80%	70%	50%	30%	20%	10%	5%	1%
1	0.016	0.064	0.148	0.455	1.074	1.642	2.706	3.841	6.635
2	0.211	0.446	0.713	1.386	2.408	3.219	4.605	5.991	9.210
3	0.584	1.005	1.424	2.366	3.665	4.642	6.251	7.815	11.341
4	1.064	1.649	2.195	3.357	4.878	5.989	7.779	9.488	13.277

Probability value:

If the probability is 5% or greater, then you can accept your **hypothesis**. If the probability is less than 5%, then reject your **hypothesis**.

Do you accept or reject your **null hypothesis**? Why? What does it mean?

Day 50

1. Plant the P_2 seeds following the growing directions from Day 0.

Day 53

1. Observe the stem color of the young P_2 plants. Record your observations in the table.

List each phenotype	Purple stem	Green stem	Purple leaf	Green leaf
F_1 generation				

Does this activity show how traits are passed from parents to offspring? Why or Why not?

Source: Wisconsin Fast Plants