

Mendel's Peas Exercise 1 - Part 1

TRUE-BREEDING ORGANISMS

Goal

In this exercise you will use StarGenetics, a genetics experiment simulator, to understand the concept of true breeding in genetics by examining a specific genetic trait, flower color, in pea plants.

Learning objectives

After completing this exercise, you will be able to:

1. Perform genetics experiments in the genetics cross simulator, StarGenetics.
2. Explain what it means for an organism to be true breeding.
3. Determine if an organism is true breeding through the analysis of results from genetic crosses.
4. Determine if individual organisms are homozygous or heterozygous for a given trait through the analysis of results from genetic crosses.

Getting started with StarGenetics

- To access StarGenetics, please navigate to: <http://star.mit.edu/genetics/>.
- Click on the **Start** button to launch the application.
- Click **Trust** when a prompt appears asking if you trust the certificate.
- Click on **File** → **New** in the drop-down menu in the upper left hand corner.
- Click on the **Mendel's Peas Exercise 1 – Part 1** file.

You are working in a company that produces strains of pea plants and ships them out all over the world to research labs. Your company prides itself on supplying only true-breeding pea plants that produce identical pea plant offspring for many generations. Your co-worker has developed two new lines of pea plants that he believes are true breeding: one with **white flowers** and one with **purple flowers**. Your current project is to confirm that the white- and purple-flowered pea plants are true breeding before the pea plants are shipped to researchers around the world. To conduct this project, you have been given two pea plants in the **Strains** box of StarGenetics: "**White Parent 1**" and "**Purple Parent 1**".

1 You will begin this project by determining whether **White Parent 1** is true breeding through an analysis of its offspring. Some plants, including the pea plants you are working with, have the ability to self-cross. This means that a single plant can generate offspring all on its own by producing both the sperm (pollen in plants) and the eggs (ovum) within each flower or within separate flowers on the same plant.

a) What is/are the flower color phenotype(s) of the F1 offspring resulting from the self-cross of **White Parent 1**?

- Self-cross **White Parent 1** by dragging **White Parent 1** to the **Mating site** twice, to act as both the ovum and pollen donor, and then click on the **Mate** button to generate F1 offspring.
- Each resulting offspring can be viewed within the **Individual** tab.
- A summary of the results is available in the **Summary** tab.
- The flower color of individual offspring can be visually observed or obtained by selecting an offspring of interest and looking in the **Properties** window.

Answer

Phenotype(s):

b) What is/are the flower color phenotype(s) of the F1 offspring from the previous cross when you analyze an additional 72 F1 progeny (for a total of 80)?

- Analyze a total of 80 F1 offspring by performing an additional 9 self-crosses.
- To add additional offspring to a cross, click on the **Add more matings** button and select the appropriate number of matings (or crosses) you would like to perform in the pop-up window to add the appropriate number of additional offspring.
- Rename this experiment by clicking the box with the current experiment name at the top of the **Active experiment** window and enter the new experiment name, "**WP Self**", when prompted. This will allow you to more easily keep track of your multiple experiments.

Answer

Phenotype(s):

c) When a plant is true breeding, all subsequent generations will also have the same, identical phenotype as the parent plant. Because it is incredibly important to guarantee that the plants your company is selling are true breeding, you decide to generate subsequent generations of **White Parent 1** by self-crossing the offspring of each subsequent cross.

i. What is/are the flower color phenotype(s) of the F2 progeny when you self-cross two F1 plants?

- To start a new mating experiment, click on the **New experiment** button. Your current experiment will automatically be saved for you.
- You can cross individual pea plants that you have generated in a previous saved experiment by dragging them from the appropriate **Saved experiments** window to the **Mating site**.
- Self-cross an F1 individual of your choice from the "**WP Self**" experiment in the **Saved experiments** window and record the flower color phenotype(s) of 80 progeny.
- Rename this experiment "**WP F1.1**".
- Self-cross a second F1 individual of your choice from the "**WP Self**" experiment in the **Saved experiments** window and record the flower color phenotype(s) of 80 progeny.
- Rename this second experiment "**WP F1.2**".

Answer

Name of 1st F1 plant selfed:

F2 Phenotype(s):

Name of 2nd F1 plant selfed:

F2 Phenotype(s):

ii. What is/are the flower color phenotype(s) of the F3 progeny when you self-cross two F2 plants?

- Self-cross an F2 individual of your choice from the "**WP F1.1**" experiment in the **Saved experiments** window and record the flower color phenotype(s) of 80 progeny.
- Rename this experiment "**WP F2.1**".
- Self-cross an F2 individual of your choice from the "**WP F1.2**" experiment in the **Saved experiments** window and record the flower color phenotype(s) of 80 progeny.
- Rename this second experiment "**WP F2.2**".

Answer

Name of 1st F2 plant selfed:

F3 Phenotype(s):

Name of 2nd F2 plant selfed:

F3 Phenotype(s):

d) Is *White Parent 1* true breeding? Why or why not?

Answer (Circle one)

Yes

No

Why or why not?

2 Next, you would like to determine whether the *Purple Parent 1* plant is true breeding.

a) What is/are the flower color phenotype(s) of the F1 offspring resulting from a self-cross of *Purple Parent 1*?

- Perform a self-cross of *Purple Parent 1* producing a total of 80 offspring.
- Rename this experiment "*PP1 Self*".

Answer

Phenotype(s):

b) To determine if the *Purple Parent 1* plant is true breeding, you also need to test the flower color phenotypes of subsequent generations of offspring.

i. What is/are the flower color phenotype(s) of the F2 progeny when you self-cross two F1 plants?

- Self-cross an F1 individual of your choice from the "*PP1 Self*" experiment in the **Saved experiments** window and record the flower color phenotype(s) of 80 progeny.
- Rename this experiment "*PP1 F1.1*".
- Self-cross a second F1 individual of your choice from the "*PP1 Self*" experiment in the **Saved experiments** window and record the flower color phenotype(s) of 80 progeny.
- Rename this second experiment "*PP1 F1.2*".

Answer

Name of 1st F1 plant selfed:

F2 Phenotype(s):

Name of 2nd F1 plant selfed:

F2 Phenotype(s):

ii. What is/are the flower color phenotype(s) of the F3 progeny when you self-cross two F2 plants?

- Self-cross an F1 individual of your choice from the "*PP1 F1.1*" experiment in the **Saved experiments** window and record the flower color phenotype(s) of 80 progeny.

- Rename this experiment “*PP1 F2.1*”.
- Self-cross an F1 individual of your choice from the “*PP1 F1.2*” experiment in the **Saved experiments** window and record the flower color phenotype(s) of 80 progeny.
- Rename this second experiment “*PP1 F2.2*”.

AnswerName of 1st F2 plant selfed:

F3 Phenotype(s):

Name of 2nd F2 plant selfed:

F3 Phenotype(s):

c) Is *Purple Parent 1* true breeding? Why or why not?

Answer (Circle one)

Yes

No

Why or why not?

3 Assuming that flower color is determined by a single gene in pea plants:

- Is *White Parent 1* homozygous or heterozygous with regard to the flower color gene?
- Is *Purple Parent 1* homozygous or heterozygous with regard to the flower color gene?

Note: You do not need to indicate the exact genotype for either plant, just think about whether the two alleles are the same or different for flower color.

- **Homozygous** means the organism has two copies of the same genetic variation, or allele, for a given trait. Therefore, a homozygous organism for a given trait can only pass on this one allele to its offspring.
- **Heterozygous** means the organism has two different variations, or alleles, for a given trait. It can pass on either allele of the trait to its offspring.

Answer (circle the appropriate answers)

Is the genotype of *Purple Parent 1*: Homozygous Heterozygous BothIs the genotype of *White Parent 1*: Homozygous Heterozygous Both

4 Another pea plant with purple flowers (*Purple Parent 2*) is mysteriously left on your desk from a secret admirer. The first thing you want to do with this plant, of course, is to determine whether this plant can be added to a collection of true-breeding plants.

a) To determine if the plant is true breeding, you must analyze the F1, F2, and F3 offspring.

i. What is/are the flower color phenotype(s) of the F1 offspring resulting from a self-cross of the *Purple Parent 2* plant?

- Self-cross *Purple Parent 2* and record the flower color phenotype(s) of 80 F1 progeny.
- Rename this experiment “*PP2 Self*”.

Answer**F1 Phenotype(s):**

- ii. What is/are the flower color phenotype(s) of the F2 progeny when you self-cross two F1 plants?
- Self-cross an F1 individual of your choice from the “**PP2 Self**” experiment in the **Saved experiments** window and record the flower color phenotype(s) of 80 progeny.
 - Rename this experiment “**PP2 F1.1**”.
 - Self-cross a second F1 individual of your choice from the “**PP2 self**” experiment in the **Saved experiments** window and record the flower color phenotype(s) of 80 progeny.
 - Rename this second experiment “**PP2 F1.2**”.

Answer**Name of 1st F1 plant selfed:****F2 Phenotype(s):****Name of 2nd F1 plant selfed:****F2 Phenotype(s):**

- iii. What flower color phenotype(s) do you observe for the F3 progeny of this **Purple Parent 2** plant?
- Self-cross an F1 individual of your choice from the “**PP2 F1.1**” experiment in the **Saved experiments** window and record the flower color phenotype(s) of 80 progeny.
 - Rename this experiment “**PP2 F2.1**”.
 - Self-cross an F1 individual of your choice from the “**PP2 F1.2**” experiment in the **Saved experiments** window and record the flower color phenotype(s) of 80 progeny.
 - Rename this second experiment “**PP2 F2.2**”.

Answer**Name of 1st F2 plant selfed:****F3 Phenotype(s):****Name of 2nd F2 plant selfed:****F3 Phenotype(s):**

b) Is *Purple Parent 2* true breeding? Why or why not?

Answer (Circle one)

Yes

No

Why or why not?

5 Based on your results from Question 4, is **Purple Parent 2** homozygous or heterozygous with regard to the flower color gene? Do the **Purple Parent 1** and **Purple Parent 2** pea plants have the same genotype? Explain.

Name: _____

Note: You do not need to indicate the actual genotype of the parents. Instead, think about whether the alleles are the same or different in each parent.

Answer (circle the appropriate answers)

The genotype of *Purple Parent 2* is: Homozygous Heterozygous

The genotypes of the *Purple Parent 1* and *Purple Parent 2* pea plants are:

 The Same Different

Why?