

Introduction

Through his careful and detailed studies with garden pea plants, the Austrian monk and scientist Gregor Mendel determined that heredity is controlled by factors that are passed from generation to generation with predictable results. Mendel's experiments and conclusions led to the formulation of several basic genetic principles.

The principle of *dominance* states that some factors (alleles) are dominant, whereas others are recessive. The effects of a dominant allele are seen even if it is present with a contrasting recessive allele. The principle of *segregation* states that during gamete (sperm and egg) formation, the alleles for a trait separate, so that each gamete has only one of the alleles for that trait. The *principle of independent assortment* states that as gametes form, the genes for various traits separate independently of one another.

In this investigation, you will construct Punnett squares to observe the principles of genetics that were based on Mendel's work.

Problem

How can the characteristics of offspring be predicted?

Procedure

Constructing Punnett Squares for a Single Trait Cross.

- Examine Figure 1. The capital letter "T" is used to represent the dominant allele for tallness in the stem length for pea plants. The lowercase letter "t" is used to represent the recessive allele for shortness in pea plants.
- Notice the genotypes, or gene combinations, that result from the parental (P) generation cross between a female purebred tall (TT) pea plant and a male recessive short (tt) pea plant. All of the offspring that make up the first Filial (F₁) generation are tall (Tt). Their phenotypes, or visible characteristics, are all tall.
- Figure 2 shows the results of a single trait cross between the offspring from the F₁ generation. Observe the genotypic and phenotypic ratios for the second filial (F₂) generation. When writing such ratios, the number(s) for the dominant genotype or phenotypes comes first. In this example, 1/4 of the offspring are TT, 1/2 (or 2/4) are Tt, and 1/4 are tt. The genotypic ratio is therefore 1/4:2/4:1/4, or 1:2:1. Three fourths of the offspring have tall stems and 1/4 have short stems. The phenotypic ratio is therefore 3/4:1/4 or 3:1.
- In soybeans, purple flower color is dominant and white flower color is recessive. Let "P" represent the dominant allele (purple), and "p" the recessive allele (white).
- Predict the probable genotypes of the first filial (F₁) generation of offspring by completing the Punnett square in Data Table 1. Indicate the genotypic and phenotypic ratios of the F₁ generation.

Figure 1

		Purebred Tall Female x Short Male		
P Generation	Genotype	TT	x	tt
		Female Gametes		
		<div style="display: flex; justify-content: space-around;"><div>T</div><div>T</div></div>		
Male Gametes	t	Tt	Tt	
	t	Tt	Tt	
F1 Generation		<div style="display: flex; justify-content: space-between;"><div>Genotypic Ratio = 100% Tt</div><div>Phenotypic Ratio = 100% Tall</div></div>		

6. In Data Table 2, cross two plants from the F₁ generation. Write the appropriate genotypes for this cross on the lines provided. Predict the probable genotypes of this cross by completing the Punnett square in Data Table 2.
7. Indicate the genotypic and phenotypic ratio of the F₂ generation in Data Table 2.

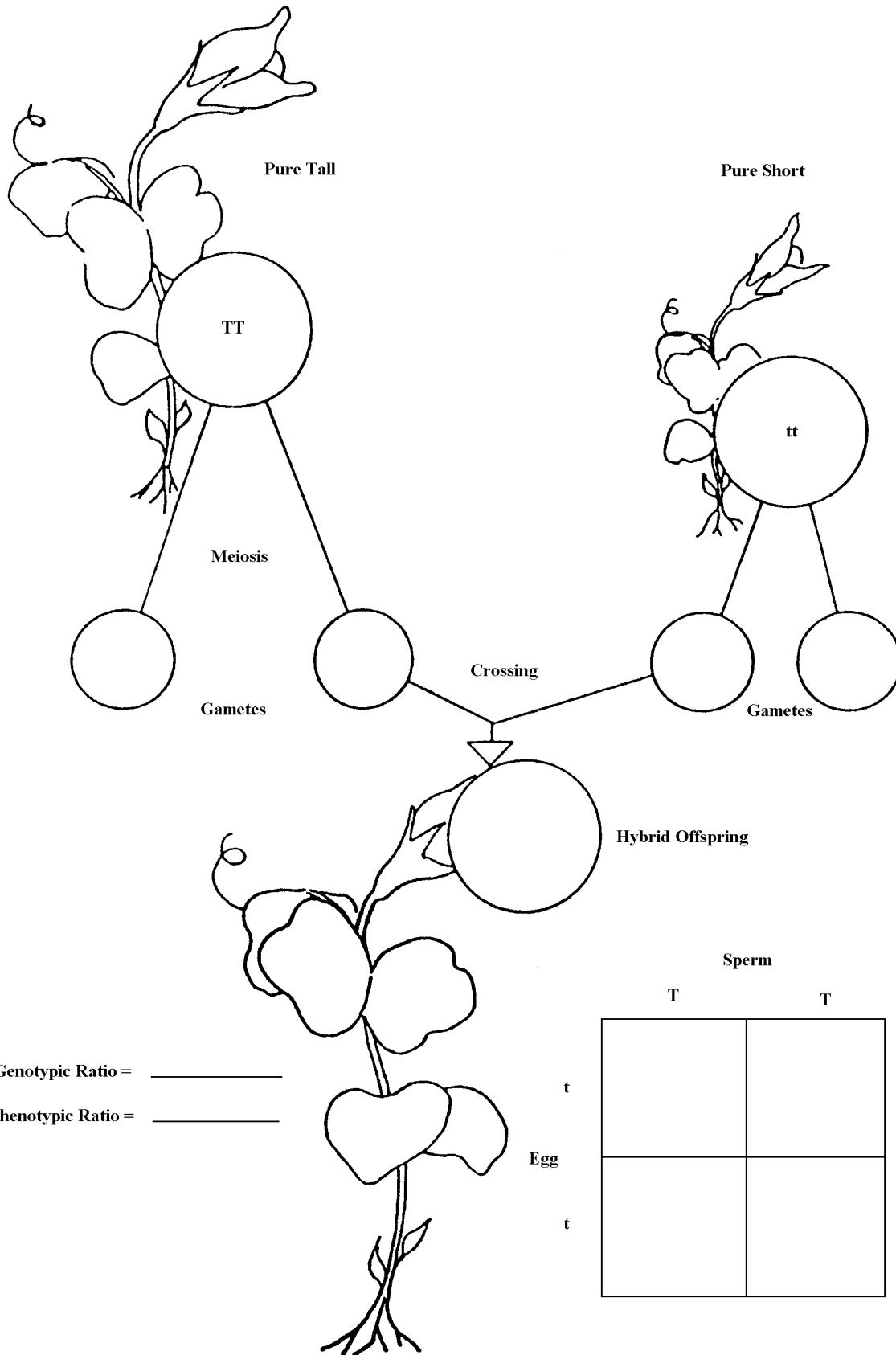
Figure 2

	Hybrid Tall Female x Hybrid Tall Male			
F1 Generation	Genotype	Tt	x	Tt
	Female Gametes			
	<div style="display: flex; justify-content: space-around;"> T t </div>			
Male Gametes	T	TT		Tt
	t	Tt		tt
F2 Generation	<div style="display: flex; align-items: center;"> { <div> Genotypic Ratio = 1:2:1 Phenotypic Ratio = 3:1 </div> </div>			

For Practice: Complete the following Punnett Squares. The first three are basic inheritance problems. The last two Punnett squares are more difficult.

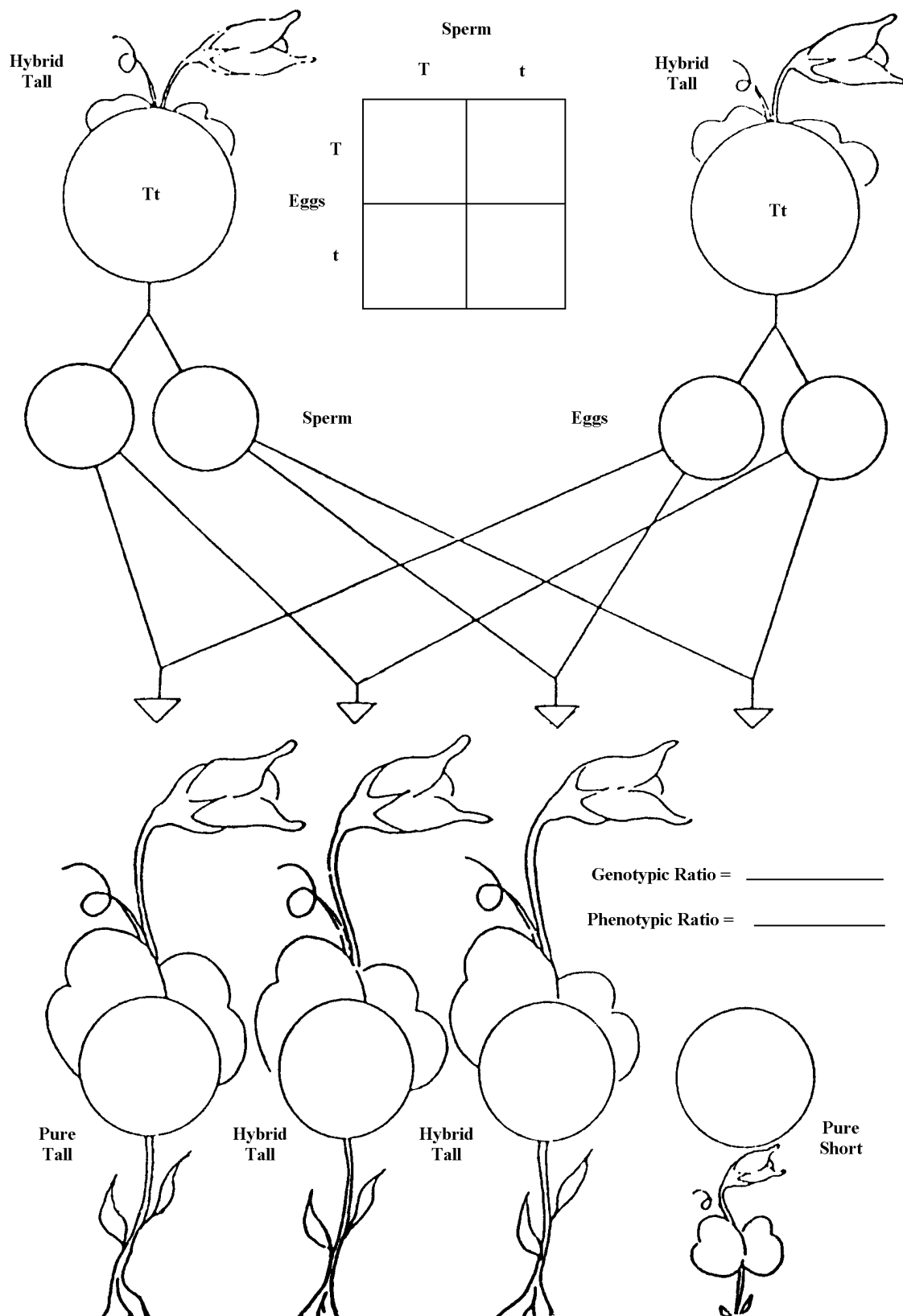
Punnett Square 1 Dominant Trait -vs- Recessive Trait

Complete the diagrams below



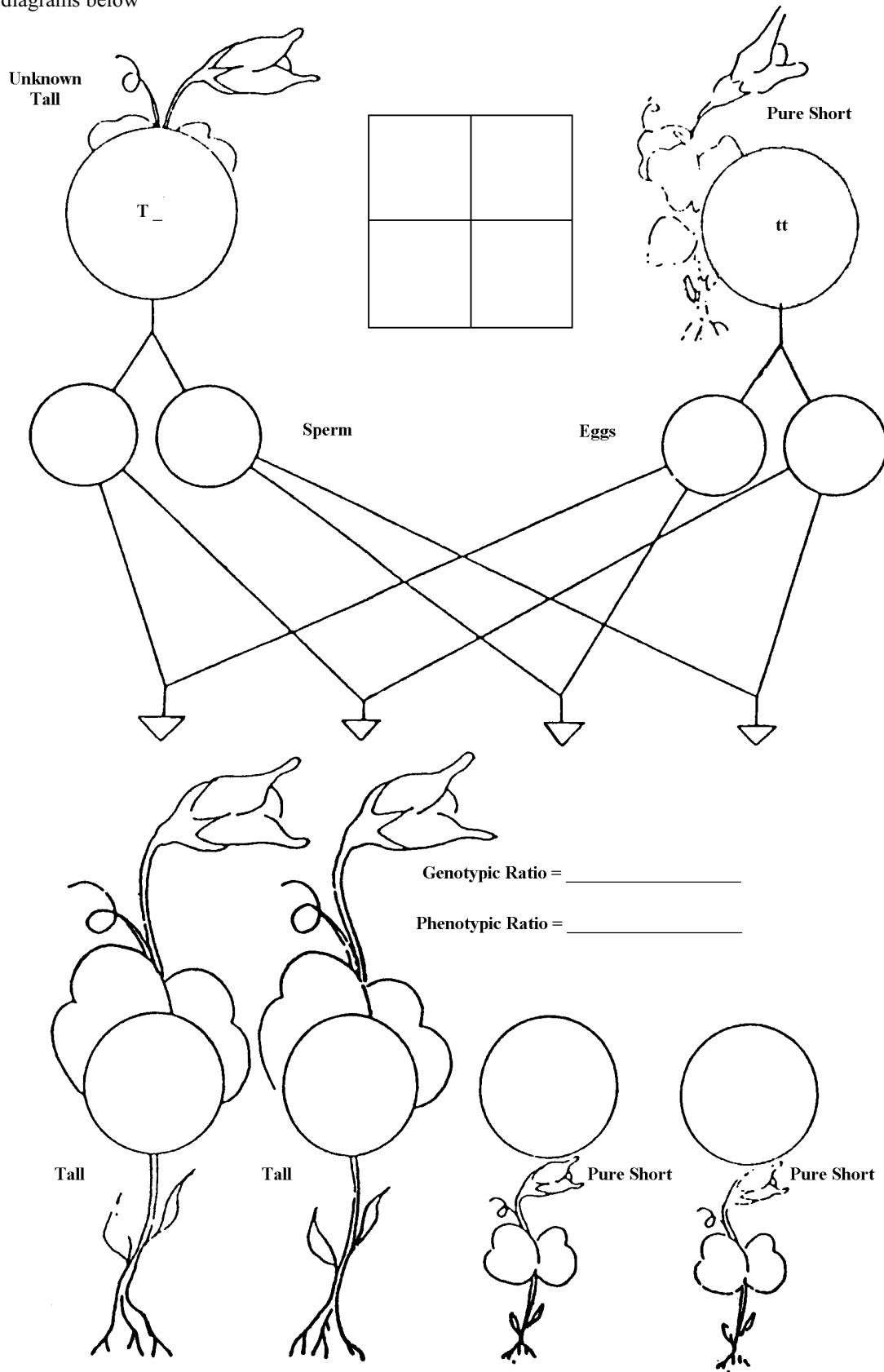
Punnett Square 2 F₁ Cross and Segregation of Traits in Gametes

Complete the diagrams below



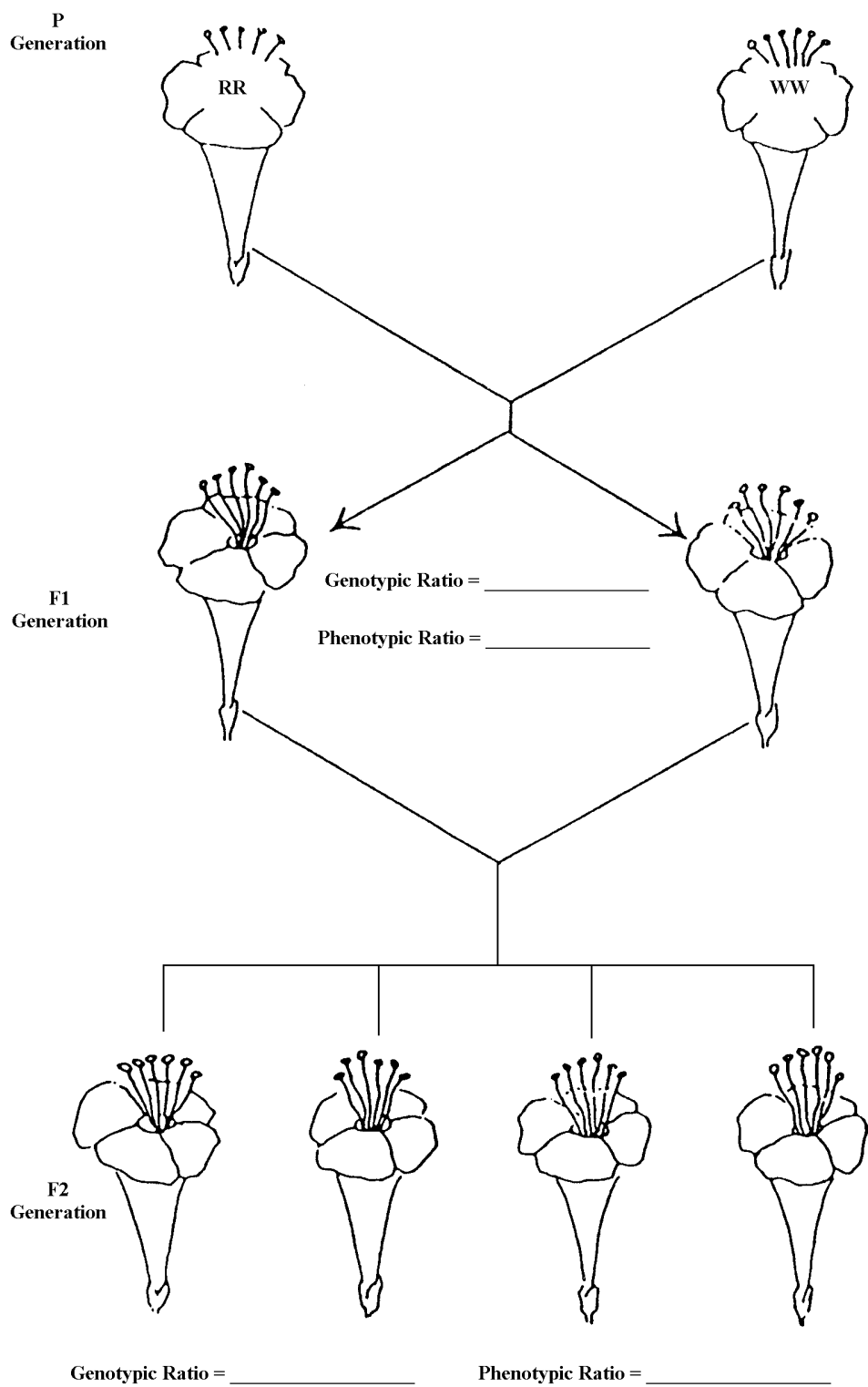
Punnett Square 3 Test Cross Used to Determine Dominant Trait as to Pure or Hybrid

Complete the diagrams below



Punnett Square 4 Incomplete Dominance in the Four-O'clock Flower

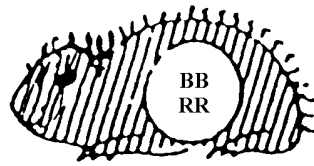
Complete the diagrams below



Punnett Square 5 Two Traits and Independent Assortment

Complete the diagrams below

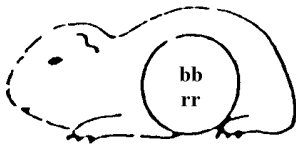
Parents



Pure Black
Pure Rough

Dominant Traits

Black (B)
Rough (R)



Pure White
Pure Smooth

Recessive Traits

White (b)
Smooth (r)

F1 Phenotypic Ratio = _____

BR

BR

br

<p>Black Rough</p>	<p>Black Rough</p>
<p>_____</p>	<p>_____</p>

F2
Generation

BR

Br

bR

br

BR

<p>Black Rough</p>	<p>Black Rough</p>		

F2 Phenotypic Ratio = _____