Name: ___________

Chapter 3-2: The Monohybrid Cross

The observations made by Gregor Mendel in the 1860s laid the foundation for the science of genetics. Mendel proposed that in a gene pair, one allele dominates over the other, recessive, allele. He theorized that alleles segregate (separate) independently during the formation of sperm and eggs and that they come together again in the new individual. In this plate, we see how this works in pea plants and we demonstrate an abbreviated way of expressing the crosses that take place.

> This plate shows two ways in which crosses are expressed in genetics. In the first view, we see the law of segregation in action as the alleles separate, then come together in the offspring. The second view shows the shorthand way that geneticists keep track of alleles in crosses. You should use the same yellow and green colors for the pea plants that you did in the previous plate.

Gregor Mendel worked with pea plants that were either yellow or green. He began with the P_1 generation of plants that produce either yellow seeds (peas) or green seeds (peas). The true-breeding yellow-seed bearing plant is the **homozygous dominant individual (A)**. This individual has two alleles for yellow seed color. The alleles are represented by two capital Y's.

The second parent in Mendel's cross had green seeds (peas). Since the green allele is masked in the offspring, this individual is the **homozygous recessive individual (B)**. Note that we represent the homozygous recessive by two small y's.

Gametes (sex cells) are formed during the process of meiosis. Each gamete has a member of the allele pair. Therefore, when the homozygous dominant individual produces gametes, all have the **dominant allele (C)**. We only show one gamete, but all of these gametes are identical. In the same way, when the homozygous recessive individual produces gametes, they possess the recessive allele. Thus, we show a **gamete with the recessive allele (D)**.

When these gametes come together to form a fertilized egg, the alleles are united and a new individual results. This individual has one allele for the yellow color (which is dominant) and one allele for the green color (which is recessive). Since the yellow allele dominates, all individuals will produce yellow seeds. These individuals are all said to be heterozygous, or **hybrids (E)**.

> We have now seen the basis for the law of segregation in which the alleles separate as gametes are formed, then come together in the new individual. We will explore this principle further as we continue with the next generation.

The first generation produced by individuals (P_1) is called the F_1 generation. When Mendel interbred these F_1 individuals, he crossed hybrids with hybrids (E). Once again, the alleles separate. In the brackets we see gametes with the yellow allele (C) and gametes with the green allele (D).

When the gametes come together, the F_2 generation forms. In one case, the offspring has yellow seeds because its alleles are YY. Geneticists say that the *phenotype* is yellow and the *genotype* is YY. When two individuals have a dominant Y gene and a recessive y gene, they are hybrid. Their phenotypes are yellow, and their genotypes are Yy. To the right, the gametes unite to form an individual with green seeds (B). Here the genotype is yy and the phenotype is green. Of the four possible combinations, three plants have yellow seeds and one has green seeds. This is the 3:1 ratio observed by Mendel. The ratio of genotypes is 1:2:1 [one homozygous dominant individual, two heterozygous individuals (hybrids), and one homozygous recessive individual].

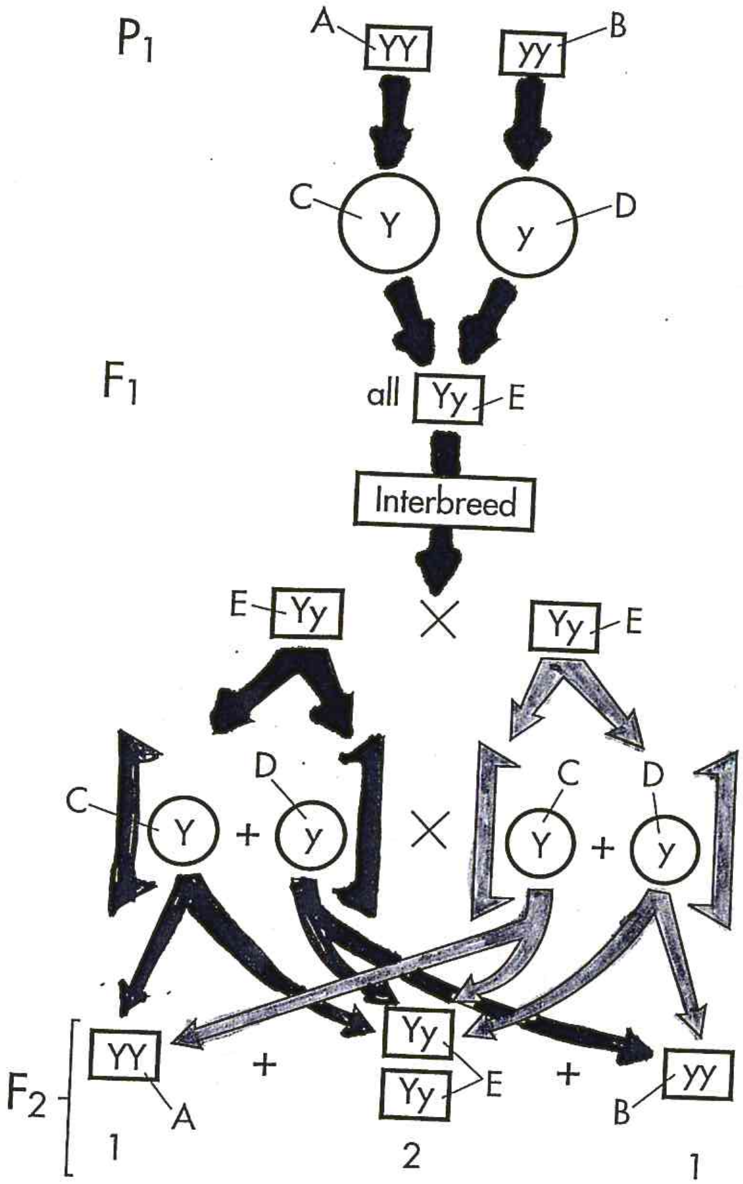
> We have seen how the law of segregation works in an actual monohybrid cross. To simplify matters, geneticists use the Punnett square.

The Punnett square is a shorthand way of showing how the gametes behave in a monohybrid cross. It is set up in the following way: the alleles are separated, and one is placed at the head of each column. This is for the male. For the female, the gametes are separated and placed along the left side of the square. Then, by simply crossing the gametes, we can see which four individuals will form. In this case, each individual formed is a hybrid (E), or is heterozygous for this particular trait.

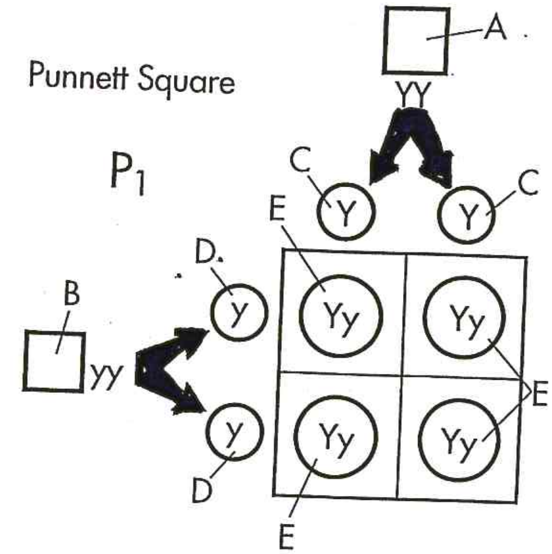
Next, we cross the F_1 generation. Here, one pair of alleles is placed at the top of the square (Yy) and the other is to the left (Yy). Now we simply cross the gametes. We again produce the homozygous individual (A), the homozygous recessive individual (B), and the two heterozygous individuals (E). This corresponds to the 1:2:1 ratio seen on the left side of the plate. The Punnett square tells us the genotype of the offspring and, by examining the genotype, we can determine the phenotype.

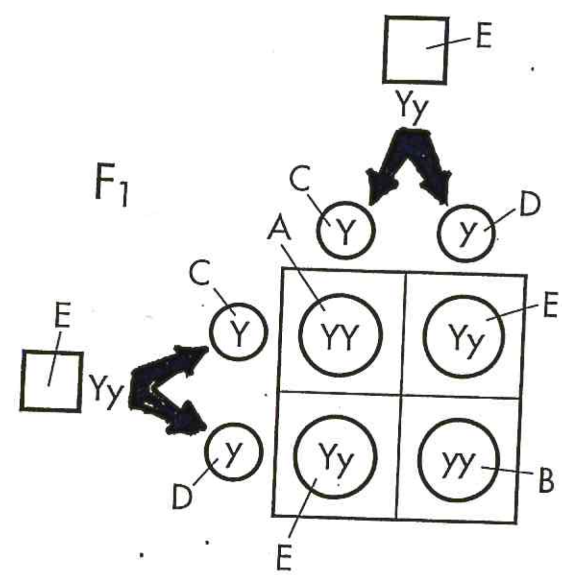
The Monohybrid Cross

Actual Crosses



Punnett Square





The Monohybrid Cross

- ○ Homozygous Dominant....A
- ○ Homozygous Recessive ..B
- ○ Gamete with Dominant Allele C
- ○ Gamete with Recessive Allele ....D
- ○ Heterozygous (Hybrid) Individual ....E