# Mendel's segregation principle of 3 to 1 ratio explained through an exemplificati...

Environment, Plants

# The Use of Genetics in Corn to Demonstrate Mendel’s Laws


## Abstract

The purpose of this experiment was to see if corn kernel genetics really do follow Mendel’s proposed 9: 3: 3: 1 and 3: 1 ratios. The importance of Mendel’s laws, the Principle of Independent Assortment and the Principle of Segregation was also investigated to see if the ratios were a result of these laws.

The results indicated that the corn kernels counted closely followed Mendel’s proposed ratios of 3: 1 and 9: 3: 3: 1. The kernels that were counted for color and texture appeared to loosely follow the 3: 1 ratio. The kernels that were counted for a combination of colors and textures (purple smooth, purple wrinkled, yellow smooth, and yellow wrinkled) appeared to loosely follow the 9: 3: 3: 1 ratio.

The most significant point that can be drawn from this is that phenotypes and genotypes can easily be calculated in many simple organism when given the proper information. With this kind of information, not only can one estimate what an organism’s offspring might look like, but one can also estimate their genetic makeup as well.

The major conclusion of this experiment is that organisms do tend to follow mendel’s genetic laws. With the Principle of Segregation, there are two alleles for each trait passed down that can be either dominant or recessive. This was proven with either the color or the texture and one of the traits masking the other. The Principle of Independent Assortment states that two

pieces of info for one trait do not influence the info for a second trait and that traits are often transformed independently as that the phenotype and genotype of the offspring may not match that of the parents. This was shown with the combination corn cobs. These two laws together create the basis for how the ratios are established.

**Introduction:**

The main components of genetics were first discovered by the monk Mendel. Mendel discovered his ideas by cross-breeding pea plants with various characteristics and seeing how their offspring resulted. One of these ideas was Mendel’s Principle of Segregation, which described how pairs of genes were separated. Genes are the basic unit of heredity. They are made of DNA and act as an instruction manual for the assembling if organisms. Everyone and thing has unique genes. These genes have forms called alleles, which come in pairs and are located in specific places on chromosomes. They code for distinct traits that can be passed to offspring. With the Principle of Segregation, there are two alleles for each trait passed down, such as the color of Mendel’s peas and the height. One piece of this info is inherited from each parent, with these traits being either dominant or recessive. Mendel’s second idea, the Principle of Independent Assortment, states that two pieces of info for one trait do not influence the info for a second trait. Traits are often transformed independently, as that the phenotype and genotype of the offspring may not match that of the parents. A phenotype is the physical appearance of something. An example of this is a peas’ color. The genotype is the coded information of something. An example of this would be the genetic code that creates the color of the pea.

The purpose of this experiment is to see if corn kernel genetics really follow Mendel’s 9: 3: 3: 1 and 3: 1 ratios, as caused by the Principle of Independent Assortment and the Principle of Segregation..

If the color and texture of corn kernels follow Mendel’s 9: 3: 3: 1 and 3: 1 ratios, and the numbers of each kind of texture and color mixture are counted, then they will proportionally be in these stated proportions to one another.

## Procedures:

In order to conduct this experiment, three kinds of corn cobs are needed: ones with two different colors of corn kernels on them, ones with two different textures of corn kernels on them, and ones that have kernels with mixed combinations of texture and color on them. Some sort of counting device may be needed as well.

Two corn cobs were obtained: one with differing kernel colors (yellow or purple) and one with differing kernel textures (smooth or wrinkled). With each cob, the number of each differing kernel was counted. Three trials were conducted. Afterwards, a corn cob with a mixture of differing colored and textured kernels was obtained, and each combination of the two traits was counted. This was done for three trials.

## Results:

Kernel Color

Average Number of Kernels

Yellow 88

Purple 212

Kernel Texture

Average Number of Kernels

Smooth 264

Wrinkled 89

Kernel Combinations

Average Number of Kernels

Purple Smooth 255

Purple Wrinkled 101

Yellow Smooth 76

Yellow Wrinkled 41

Chi Square Tests:

Colors

Color Observed Expected (Observed-Expected)

2 / Expected

Yellow 88 75 2. 25

Purple 212 225 . 87

Textures

Texture Observed Expected (Observed-Expected)

2 / Expected

Smooth 264 264 0

Wrinkled 89 89 0

Combinations

Combination Observed Expected (Observed-Expected)

2 / Expected

Purple Smooth 255 270 . 45

Purple Wrinkled 101 90 1. 61

Yellow Smooth 76 90 1. 90

Yellow Wrinkled 41 30 4. 03

Variable 1, Kernel color (figure 1)

In this table, it can be seen that there were more purple corn kernels counted than yellow kernels counted. There were 212 purple kernels, and only 88 yellow kernels.

**Variable 2, Kernel texture (figure 2)**

In this table, it can be seen that there were more smooth corn kernels counted than wrinkly kernels counted. There were 264 smooth kernels, and only 89 wrinkled kernels.

**Variable 3, Kernel combinations (figure 3)**

In this table, there were several different combinations of kernel texture and color combinations examined: purple smooth, purple wrinkled, yellow smooth, and yellow wrinkled. it can be seen that most of the kernels on the cob were purple and smooth, with 255 of them being counted. The second highest amount of kernels were the purple and wrinkled kind, with 101 counted. Following close behind in the third highest amount were the yellow smooth kernels, with 76 of them counted. The combination that was least present were the yellow wrinkled kernels, with only 41 counted.

**Chi square test 1, Kernel color (figure 4)**

In this table, it can be seen that there were more purple corn kernels observed than yellow kernels counted. There were 212 purple kernels, and only 88 yellow kernels. The expected column was derived from the fact that the kernels were expected to follow Mendel’s 3: 1 ratio. To obtain these results, the overall number of kernels first had to be calculated, which added up to 300 kernels. This number was then divided by four, the sum of the ratio numbers, to create a base number of 75. Since the expected ratio for yellow kernels was one, 75 was multiplied by one to give the expected number 75. Since the expected ratio for purple kernels was 3, 75 was multiplied by 3 to give the expected number 225. The final column was

evaluated by subtracting the expected column from the observed column and squaring it. This number was then divided by the expected column.

**Chi square test 2, Kernel texture (figure 5)**

In this table, it can be seen that there were more smooth corn kernels observed than wrinkled kernels counted. There were 264 smooth kernels, and only 89 wrinkled kernels. The expected column was derived from the fact that the kernels were expected to follow Mendel's 3: 1 ratio. To obtain these results, the overall number of kernels first had to be calculated, which added up to 353 kernels. This number was then divided by four, the sum of the ratio numbers, to create a base number of 89. Since the expected ratio for yellow kernels was one, 89 was multiplied by one to give the expected number 89. Since the expected ratio for purple kernels was 3, 89 was multiplied by 3 to give the expected number 264. The final column was evaluated by subtracting the expected column from the observed column and squaring it. This number was then divided by the expected column.

**Chi square test 3, Kernel combinations (figure 6)**

In this table, there were several different combinations of kernel texture and color combinations examined: purple smooth, purple wrinkled, yellow smooth, and yellow wrinkled. it can be seen that most of the kernels on the cob were purple and smooth, with 255 of them being counted. The second highest amount of kernels were the purple and wrinkled kind, with 101 counted. Following close behind in the third highest amount were the yellow smooth kernels, with 76 of them counted. The combination that was least present were the yellow wrinkled kernels, with only 41 counted. The

expected column was derived from the fact that the kernels were expected to follow Mendel’s 9: 3: 3: 1 ratio. To obtain these results, the overall number of kernels first had to be calculated, which added up to 473 kernels. This number was then divided by 16, the sum of the ratio numbers, to create a base number of 30. Since the expected ratio for yellow wrinkled kernels was one, 30 was multiplied by one to give the expected number 30. Since the expected ratio for both purple wrinkled kernels and yellow wrinkled kernels was 3, 30 was multiplied by 3 to give the expected number 90. Finally, since the expected ratio for purple smooth kernels was nine, 30 was multiplied by nine to give the expected number 270. The final column was evaluated by subtracting the expected column from the observed column and squaring it. This number was then divided by the expected column

**Discussion:**

The corn kernels did follow Mendel’s discovered ratios and principles. This did, in fact, support the hypothesis. It can be seen from the first set of data, the one involving the counted colors of corn kernels, that this ratiuo did follow the 3: 1 ratio. Purple kernels were found to be dominant, while the yellow kernels were recessive.. This was gathered by the fact that the number of purple kernels almost tripled the number of yellow kernels at an average of 212 rather than 88. With the texture of the peas, the smooth kernels almost tripled the number of wrinkled kernels at an average of 264 rather than 89 kernels. The combinations of colors and textures also followed the hypothesis, abiding by the 9: 3: 3: 1 ratios. The number purple smooth kernels were on average nine times greater than the others at 255. Both the purple wrinkled kernels and the yellow smooth kernels served as the threes

in the ratios, having amounted to 101 kernels and 76 kernels respectively. The yellow wrinkled kernels had the fewest number of kernels at 41. The results of the chi square tests go on to further confirm these results.

The results of this experiment can be easily explained. Purple kernels were found to be dominant, while the yellow color was recessive. This followed Mendel’s Principle of Segregation, which states that the two alleles from the parents are passed down to the offspring and separated. The traits are either dominant or recessive. With the kernel color, the purple allele masked the yellow allele. It would require two yellow alleles in order for the yellow color to show through. As such, the crossbreeding would create the 3: 1 ratio. The same could be said for the texture of the kernels. In this case, smooth kernels were dominant while wrinkled peas were recessive. They followed the 3: 1 ratio. With the combination of colored and textured kernels, the 9: 3: 3: 1 ratio was found due to the fact that the purple color was dominant, along with the smooth texture. The number of dominant or recessive alleles that the plant received would determine which combination of kernel it would have. This followed Mendel’s Principle of Segregation, The purple and smooth traits masked over the yellow and wrinkled traits, explaining why these ratios were obtained in crossovers that led to the offspring’s genotype and phenotype.

This is believed to be a straightforward explanation, without much room for interpretation.

Based upon the discussion of the results obtained, there could be further work to be done in order to gain more insight on the subject of genetics and genetic variation. This experiment was focused solely on the usage of corn. It could be worthy to follow up with an investigation on whether or not other other vegetation, such as with the seeds of a watermelon, exhibit these ratios. By investigating more species and examples, one could search for possible exceptions to the ratios stated by Mendel.