BIO LAB:
Corn Genetics

TEACHER

LEVEL: Year 11&12

TOPIC: Genetics

TIME REQUIREMENT: 45 mins

CURRICULUM ALIGNMENT

- *Select, construct and use appropriate representations, including models of DNA replication, transcription and translation, Punnett squares and probability models of expression of a specific gene in a population, to communicate conceptual understanding, solve problems and make predictions (ACSBL066)*
- *Frequencies of genotypes and phenotypes of offspring can be predicted using probability models, including Punnett squares, and by taking into consideration patterns of inheritance, including the effects of dominant, autosomal and sexlinked alleles and multiple alleles, and polygenic inheritance (ACSBL085)*
- *Natural selection occurs when selection pressures in the environment confer a selective advantage on a specific phenotype to enhance its survival and reproduction; this results in changes in allele frequency in the gene pool of a population (ACSBL090)*

BACKGROUND

Often referred to as the father of genetics, Johann Gregor Mendel worked tirelessly with over 10,000 pea plants over eight years. He maintained comprehensive information on the offspring figures and types to produce mathematical patterns of inheritance and develop the three Laws of Heredity. These laws, still in use today, are the Law of Segregation, the Law of Independent Assortment and the Law of Dominance. The Law of Segregation refers to each trait being defined by a pair of genes, and parental genes that are randomly separated into sex cells. In this case, the offspring inherit one genetic allele from each parent. The Law of Independent Assortment refers to genes that are sorted separately so the inheritance of one trait is not dependent on the inheritance of another trait. The Law of Dominance refers to alternate gene forms that express the form that is dominant. Corn is an excellent model to study Mendelian genetics as thousands of individual plants are not required. A single corn cob can have as many as 200 kernels. Each kernel represents a potential offspring. The colours of the corn kernels are inherited from the 'parent' plants. The corn kernels exhibit a large quantity of easy to recognise phenotypes through the colour and form. Purple corn results from a dominant allele, whereas yellow corn is produced by a recessive allele of the same gene. The F1 of the purple cross yellow expresses the purple phenotype and looks like the purple parent stock, but it carries the recessive allele for yellow. In nature when the F1 kernels grow and are allowed to freely cross-pollinate, the recessive phenotype reappears in the resulting F2 ears in a 3:1 ratio. The phenotype breakdown for the purple: yellow cross consists of 3 purple (dominant) and 1 yellow (recessive).

In this practical, students explore how Mendel's laws of inheritance can be applied to corn. Students gather data on two monohybrid crosses and develop punnet squares on the crosses. The first monohybrid cross is the P1 (parental) generation; purple starchy crossed with yellow starchy. In this practical, students observe the phenotype of the resulting F1 generation as well as the second monohybrid cross; F1 crossed with F1 corn. Students have the opportunity to understand and observe monohybrid crosses without the time and preparation required to perform the genetic crosses prior to analysis. With each corn ear having approximately 200 or more kernels (potential offspring), only a few are required to create a reliable data set in the classroom.

MATERIALS

- Corn Genetics Set

TEACHER TIP

To further explore the mode of inheritance in the class results, consider using the Maize Ear Display Mount as part of your class discussions.

SAFETY PRECAUTIONS

- Under no circumstances are the materials used in the practical to be consumed as food.
- The corn ears are treated with a sealant, however, be aware that the corn may trigger reactions in individuals with corn allergies or sensitivities.
- Wash hands thoroughly before and after the practical or handling any organic materials.
- Wear appropriate personal protective equipment (PPE).
- Sterilise work surfaces before and after the practical.

SOUTHERN Biological

PREPARATION - BY LAB TECHNICIAN

General Preparations

1. Examine the ears of corn to check that no kernels are not missing. Ears with missing kernels, may affect the ratio of phenotypes.
2. Store the corn ears in a sealed container in a cool dry place when they are not in use.

METHOD - STUDENT PRACTICAL

Inspecting the Corn Kernels

1. Inspect the first generation (F1) offspring. This has been produced via a cross of 1purple kernel and 1 yellow kernel parent.
2. Record your observations in Table 1.
3. Inspect the second generation (F2) of corn and count the number of each different phenotype exhibited in the colour of the kernel. Any purple at all must be recorded as purple.
4. Add your count of F2 corn kernels data to Table 2.
5. Keep a record of the class data for analysis

Making Punnett Squares

1. List the genotype for the parent and F1 generations, using R to represent purple colouring and r to represent yellow.
2. Using the genotype for the parent and F1 generations, perform a cross between a homozygous purple parent and yellow parent. Use a Punnett square to illustrate your answers.
3. Perform a cross between two F1 offspring using a Punnett square.
4. Calculate the ratio of phenotypes of the F2 generation and compare the calculated class phenotype ratio and the F2 generation ratio.

OBSERVATION AND RESULTS

Below is a summary of the expected results of the above procedure. This is to be used as a guide only, as individual results will vary.

	Phenotype (Colour)	Phenotype (Colour)
F_1	All purple	
F_2	Purple	Yellow

Table 1: Corn Kernel Phenotype

F_2	Phenotype (Colour)	Phenotype (Colour)
Group	180 Purple	60 Yellow
Class totals	1442 Purple	478 Yellow
Class Percent	(1442/1920) x 100 =75%	(478/1920) x 100 =25%

Table 2: Count of F2 Corn Kernels

	R	R
r	Rr	Rr
r	Rr	Rr

Figure 1: Cross between a Homozygous Purple Parent and Yellow Parent

	R	r
R	RR purple	Rr Purple
r	Rr Purple	Rr yellow

Figure 2: Cross between Two F1 Offspring

Ratio of Purple to yellow	75/25=3:1or 144/478=3:1

Figure 3: Ratio of Phenotypes of the F2 Generation

INVESTIGATIONS

- Ask your students to consider if there is any evidence to support the idea that one of the phenotypes is dominant.
- Based on the F2 generation data, ask students which phenotype exhibits recessive traits. Students should provide evidence for their answers.
- Challenge your students to identify which of Mendel's laws is being investigated in this practical and provide evidence to support their answers.