

GENETICS OF SELU



THEMES:

- Cultural significance of corn (selu)
- Agricultural technology
- Indigenous science
- Genetics

GRADE LEVEL(S):

- 7th (6th & 8th overlaps)

DURATION:

- 2 class periods of 45-50 min.

SKILLS

- Identifying patterns
- Making Connections
- Gathering Information
- Creating, Synthesizing
- Citing Evidence
- Comparing, Analyzing
- Observing, Experimenting

BEST TIME FOR ACTIVITY:

- Anytime

SUMMARY

Interplay of culture and science

This lesson is an exploration of the genetics of corn, specifically a monohybrid cross and the resulting pigmentation. Using Punnett squares, students predict the phenotype of generations of corn and experiment to confirm their hypothesis.

OBJECTIVES AND CONNECTIONS

Students will be able to...

- Collect and organize data from genetic crosses.
- Predict patterns of inheritance given relevant data and using a Punnett Square.
- Understand the difference between phenotypes and genotypes.
- Understand the significance of selu / corn to the Cherokee culture.

MATERIALS

Preparation

- Set up Interactive Presentation Board
- Print worksheets
- (16) Black vis-a-vis wet erase markers*
- (16) Blue vis-a-vis wet erase markers*

Activity

*Materials designated with a * will be provided in the activity box.*

- Computer and projector
- PowerPoint Presentation* (on flashdrive)
- 16 ears of purple:yellow corn* (or laminated images)
- Genetics of Selu student worksheet (1 per student)*
- Cherokee historic photos activity file*



CURRICULUM CORRELATIONS - NC & TN



NORTH CAROLINA SCIENCE CORRELATIONS

- ✓ LS.7.2.1 Construct an explanation supported with scientific evidence to summarize the role of genes on chromosomes as inherited cellular structures which contribute to an organism's traits (not to include the structure of DNA).
- ✓ LS.7.2.3 Use models (Punnett squares) to infer and predict patterns of the inheritance of single genetic traits from parent to offspring (including dominant and recessive traits).

NORTH CAROLINA SOCIAL STUDIES CORRELATIONS

- ✓ 7.G.1.1 Explain how environmental conditions and human response to those conditions influence modern societies and regions (e.g. natural barriers, scarcity of resources and factors that influence settlement).

NORTH CAROLINA MATH CORRELATIONS

- ✓ 7.RP.2 Recognize and represent proportional relationships between quantities.
-

TENNESSEE SCIENCE CORRELATIONS

- ✓ 7.LS3: Heredity: Inheritance and Variation of Traits

TENNESSEE SOCIAL STUDIES CORRELATIONS

- ✓ 5.27: Identify the cultures of the major Indigenous settlements in Tennessee (Archaic, etc.).
- ✓ 5.28: Identify the pre-colonial American Indian tribes residing in Tennessee.
- ✓ 6.G.1.4: Explain how and why civilizations, societies and regions have used, modified and adapted to their environments (e.g....farming techniques).
- ✓ 7.54: Explain the impact of geographic features on North American Indian cultures (tools, etc.).
- ✓ 7.55: Describe the diverse networks of North American Indian cultures (customs, etc).
- ✓ 6-8. SSP.05: Develop historical awareness by identifying patterns of continuity and change over time, making connections to the present.

TENNESSEE LANGUAGE ARTS CORRELATIONS

- ✓ 7.SL.CC.1 Prepare for collaborative discussions on 7th grade level topics and texts; engage effectively with varied partners, building on others' ideas and expressing one's own ideas clearly.
- ✓ 7.SL.PKI.4 Present claims and findings, emphasizing salient points in a focused, coherent manner with pertinent descriptions, facts, details, and examples; use appropriate eye contact, adequate volume, and clear pronunciation.





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About this project:

The Seeking Paths in Nature (SPiN) project was developed through a partnership between Great Smoky Mountains National Park (GRSM) and the Cherokee Preservation Foundation. SPiN encompasses the focused efforts to enlighten the public, students, and GRSM employees on the history and cultural connections inherent between the Cherokee and the land, currently deemed as Great Smoky Mountains National Park, as well as surrounding communities.

Background Information:

The land of Great Smoky Mountains National Park lies on the traditional homeland of the sovereign nations of Cherokee, or Aniyuwiya*, (*pronounced “a-nee-ya-wee-ya”) meaning the Principal People. We recognize the Cherokee and their ancestors as the original and continuing stewards of this land, going back to time immemorial. The Cherokee have a deep, complex, and reliant relationship with the land. Their intimate knowledge and relationship with the land along with the seasonal availability of plants and animals has resulted in stories, medicinal remedies, foodways, arts, technologies, science, and many other practices that prioritize ecologically sustainable stewardship and partnership with the land. Many Cherokee continue these significant traditions.

Vast changes to the land came in the late 1700s when European immigrants, largely of Scotch-Irish heritage, moved to the Southern Appalachians. The massive influx of people and greediness led to disputes and conflicts between the Europeans and Cherokee, eventually resulting in the tribe being forced to sign over their lands first to Great Britain, and later to the United States. Though some found ways to remain on their traditional lands in the 1830s, most Cherokee were forced to move west. Nearly 16,000 Cherokee were forced to walk to newly appointed Cherokee lands located in present-day Oklahoma. This tragic journey is known as the “Trail of Tears” due to the deaths of approximately 4,000 Cherokee people. Since the arrival of settlers, there have been many impacts of colonization including wars, conflicts, disease, broken treaties, land resource exploitation, forced assimilation, and genocide. Despite it all, the Eastern Band of Cherokee Indians have persevered.

Today, the Cherokee live on just a small fraction of their traditional homelands known as the Qualla Boundary. They are revitalizing their culture through efforts such as language preservation, the arts, education, community building, natural resource management, and commercial enterprises. Currently, the EBCI Qualla Boundary adjoins a southern portion of Great Smoky Mountains National Park, and the Cherokee proudly proclaim: “Si O Tse Do Ha”*, (*pronounced “she oh tsay doe ha”) or “We’re Still Here!”



Acknowledgements:

Special thanks for contributions from the Cherokee Preservation Foundation, Friends of the Smokies (FOTS), Great Smoky Mountains Association (GSMA), Cherokee Central Schools, Eastern Band of Cherokee Indians (EBCI) Natural Resources, Museum of the Cherokee Indian (in particular *Dakota Brown and Dawn Arneach*), EBCI Speaker's Council [*Laura Pinnix, Roger Smoker, Bo Lossiah, Marie Junaluska, Mary Wachacha (in memoriam), and Dr. Hartwell Francis*]. For your insight, we thank *Russ Townsend*, EBCI Tribal Historic Preservation Office Program (THPO), and the many teachers who assisted in content creation and piloting [*Jessica Metz, Malia Crowe Skulski, Kaitlin Roberts, Matt Tooni, Lizzie Carver, Amanda Clapp, Nikki McCoy, Randi Neff, Max Lanning, Melissa Crisp, Judy Dulin, Michelle Whaley, and Brian Hardison*], community members *Louise & Butch Goings, Peggy Hill-Kerbow*. The National Park Service (NPS), AmeriCorps Project Conserve members, and Great Smoky Mountains National Park Education staff and interns.

Thank you to our project coordinators whose leadership and creative energy were vital to the success of this project. *Jessica Metz* led the project in 2014 – 2016, *Julie Townsend* (in memoriam) led the project from 2016-2019. For their seasonal terms as project assistants, we thank *Jessica Stump, Natrieifia Miller and Kahawis*.

We dedicate this curriculum guide in the memory of Julie Townsend; her good humor, knowledge and relationships in the community are missed daily. Julie lived her life by the Cherokee concept of Gadugi - “we learn together” and it is with this intent that we offer these activities to you.

We acknowledge that the spelling of Cherokee words included in these documents may differ slightly, as there are variations of Cherokee dialects within EBCI.



NATURAL RESOURCES
EASTERN BAND OF CHEROKEE INDIANS



IN-CLASS ACTIVITY

VOCABULARY AND DEFINITIONS



Grade Level: 7

Subject Area: Science

Activity time: 45 minutes

Setting: Classroom

Skills: Analyzing, Listening,
Listing, Organizing

Materials: Computer(s)
with internet connection /
projector

Objectives:

Students will be able to...

Collect and organize data from genetic crosses.

Predict patterns of inheritance given relevant data.

Vocabulary:

- **Agriculture:** the science or practice of farming, including cultivation of the soil for the growing of crops and the rearing of animals to provide food and other products.
- **Allele:** One of two or more alternative forms of a gene that arise by mutation and are found at the same place on a chromosome.
- **Annual plant:** completes its life cycle from germination to the production of seed, within one year and then dies.
- **Chromosome:** A threadlike structure of coiled DNA helices and protein found in the nucleus of most living cells, carrying genetic information in the form of genes.
- **Dominant Trait:** Signified by capital letter, this trait will “overpower” the recessive trait.
- **DNA:** Deoxyribonucleic acid is a self-replicating material which is present in nearly all living organisms as the main component of chromosomes. It has the form of a double helix and is the carrier of genetic information.
- **Gene:** A gene is a part of DNA (the genetic instructions in all living things). People inherit one copy of each gene from their mother and one copy from their father.
- **Genotype:** is the information contained within two alleles, the genetic makeup of an organism that results in some of the physical characteristics of that organism. Genotypes can only be determined by biological tests, not observations.
- **Heterozygous:** having two different alleles for a single trait. (Aa).
- **Homozygous:** having identical pairs of genes for any given pair of hereditary characteristics. (AA,aa).
- **Monocot:** having one cotyledon, or food stores, within one seed.
- **Native plant:** occurs naturally in a particular region, habitat, or ecosystem.
- **Phenotype:** an organism’s expressed physical traits. Phenotype is determined by an individual’s genotype and expressed genes, random genetic variation, and environmental influences.
- **Producer:** green plants that synthesize food through the process photosynthesis.
- **Punnett Square:** a square diagram used to show possible genotype combinations to predict offspring traits. (Punnett = basket)
- **Recessive Trait:** Signified by lowercase letter, this trait is only expressed when the dominant is not present.
- **Sample/Sampling:** data collected on a smaller representative subset of a larger group that would be impractical to collect in its entirety, usually randomized to prevent biased results from experimenters.
- **Selu:** Pronounced “shay-loo”, Cherokee word for corn, also known through story as the Corn Mother.
- **Zea Mays:** the scientific name for corn, also known as maize.



IN-CLASS ACTIVITY 1

DISCUSSION: HISTORY AND CULTURE OF SELU



Background: (can use Powerpoint to lead discussion)

What is Selu? Corn and its cultural importance

From the earliest times in Cherokee history, the raising of corn was interwoven with the spiritual beliefs of the people. In fact, the Cherokee name for corn, “Selu”, is also the name for the First Woman in the Cherokee creation stories.



What do we know about it's history? “Corn originated in the America’s. Called Maize (*Zea Mays* - scientific name) in many languages, corn was first cultivated in the area of Mexico more than 7,000 years ago, and spread throughout North and South America” (<http://www.npshistory.com/publications/dewa/spanning-the-gap/v22-1-2.pdf>). Both in ancient times and now, corn was often used as deer lure. During the Mississippian period (~900-1600 CE), stalks around the outside of the field were left stand-ing in the winter - one reason may have been to attract deer and allow hunters to stay closer to home in the winter months

Corn (Selu), beans (tu-ya), and squash (wa-gi-ga), known as the “3 Sisters” to many eastern wood-land tribes, are planted together for several reasons. The corn stalk provides structure for the climbing vines of the bean plants; the bean plants add beneficial nitrogen to the soil; the large-leaved, low-growing squash plants provide ground cover that keeps away weeds. These crops provided the means by which American Indians, during the Mississippian period, were able to increase their population and leisure time. Several varieties were developed and cultivated, including Cherokee Long Popcorn, Cherokee Yellow Dent Corn, Cherokee White Flint Corn, Cherokee Eagle Corn, and Cherokee Gem Glass Corn.

Through time, the Cherokee also refined their planting, cultivating, and harvesting techniques. They used a method called “hilling”, piling dirt around the base of the cornstalk to provide drainage. Cherokee also had an ingenious method of pest control; they hung gourds around their garden to attract nesting by purple martins. These birds would aggressively defend their territory against crows and blackbirds, both of which could destroy newly planted corn.

Corn continues to play an important role in the societies of Cherokee and many other Indigenous peoples. More than simply food, corn is important to the cultural and religious practices of the Cherokee people. Every Fall a Green Corn Ceremony is held to celebrate the harvest of the year’s crop.

Genetics of Selu

Though it had been grown in its first forms for more than a thousand years, in the Mississippian Period, new va-rieties of corn emerged for different purposes. One with more kernels was developed called Eastern Flint.

Ultimately, most differences in the appearance and qualities of corn – and humans as well as all life – come down to a simple molecule known as DNA. Ask students if anyone is familiar with DNA.



Procedure:

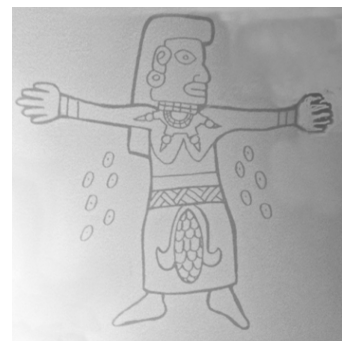
1. Historic Photos Activity - (optional) - lead discussion utilizing historic photos as an introduction to the unit.
2. (Optional) Video: *Popped Secret: The Mysterious Origin of Corn* online video with the link provided under “Extension Activities.” Recommended to load video before class so it has time to buffer.
3. Genetics of Selu PowerPoint presentation and discussions about historic and modern use of corn and segue into genetics content and discussion.
4. The Genetics of Selu worksheet should be completed along with the Powerpoint.

Extension Activities / Videos:

1. Popped Secret: The Mysterious Origin of Corn (online video 20:00 min) that discusses how corn as we know it came to be, discusses genetics and archaeology:
<https://www.biointeractive.org/classroom-resources/popped-secret-mysterious-origin-corn>
2. Visit one of the many gardens in the area or contact a local farmer to visit the classroom.
3. Plan a trip to Great Smoky Mountains National Park to visit the Mountain Farm Museum and Mingus Mill for information on growing and processing corn during the late 1800’s in Appalachia.
4. Visit the Museum of the Cherokee and the Oconaluftee Indian Village in Cherokee, NC.

References:

- Living Stories of the Cherokee: University of North Carolina Press (1998).
- Cherokee Heritage Trails Guidebook. Riggs, B. & Duncan, B.
- Mooney, James - Kanati and Selu: The origin of game and corn. From Myths of the Cherokee (1897-98)
- Spanning the Gap: Corn, An American Native. <http://www.npshistory.com/publications/dewa/spanning-the-gap/v22-1-2.pdf>
- Leaving the Past Behind: Corn Reproduction & Genetics. E.J. Finnegan and Emma Whitelaw, 2008.
<https://www.ncbi.nlm.nih.gov/pmc/articles/PMC2569149/?tool=pmcentrez>
- The Heritage of Cherokee Agriculture (pamphlet)
- Garden Genetics: Teaching with Edible Plants (other activities)
- Itse Selu by Daniel Pennington(book) - discuss Green Corn Festival, Cherokee language
- Discuss current EBCI projects: seed banks, garden wagon, etc. Visit <https://ebci.ces.ncsu.edu/>
- Visit other sites: <https://www.blueridgeheritage.com/heritage/agriculture/cherokee-agriculture/>
- <https://shiyo.org> - language app at <https://shiyo.org/fall-foods>



IN CLASS ACTIVITY 2

DISCUSSION: GENETICS OF SELU



Genetics Background:

What is DNA?

Simply put DNA is like a recipe book that tells your body how to grow and express itself. DNA is passed down from one generation to the next, from parents to offspring. This transfer of DNA, of this recipe book, is known as *heritability*. This explains why we often look similar to our parents, brothers, sisters, and other family relatives.

DNA is how similar traits are transferred from one generation to the next. This information is encoded in the twisting structure of DNA by four chemical building blocks known as *nucleotides*. The four *nucleotides* are adenine, thymine, cytosine and guanine (A,T,C, and G for short). These bases pair specifically (A with T, C with G) and the body reads these chemical cues in order, growing accordingly. In every human's complete set of DNA, there are about 3 billion of these pairs of letters. If you printed these pairs out 1mm apart on paper, these letters in your genome would extend from this area to about Arizona (1800+ miles)!

Genes, Chromosomes & Alleles

All of this DNA is organized into special bodies known as *chromosomes*. Each person (usually) has 23 pairs of chromosomes in each cell (23 from the mother and 23 from the father). In these chromosome, sections of our DNA that code for specific traits are known as *genes*.

Each gene codes for a specific protein. The proteins are the true workhorses of our cells. Proteins are responsible for every aspect of our lives – they dictate how we look (for example a protein determines our eye color), they allow our nerves to function so we can read and understand this text, they allow us to digest our food, etc.. Almost all critical functions of cells, and therefore multicellular organisms such as corn plants, are controlled by proteins that are coded for by DNA.

Each gene has multiple versions or *alleles*. Some genes have only two alleles, for example eye color is partially controlled by a gene with two versions – the brown-eye allele and the blue-eye allele. Some genes have many alleles, like blood type.

Organisms, including humans, corn plants and many others, are called *diploid* because each of their cells contains paired sets of chromosomes (di = two). Therefore, there are two alleles for each gene in a diploid cell. If an individual happens to inherit two of the same allele (for example a brown-eye allele from mom and a brown-eye allele from dad), that individual is said to be homozygous for that gene (homo = same). If an individual happens to inherit two different alleles (for example a brown-eye allele from mom and a blue-eye allele from dad), that individual is said to be heterozygous for that gene (hetero = different). It is an individual's specific combination of alleles that determines their outward appearance, or phenotype. Some genes have alleles that are dominant over other alleles. In the case of eye color, the brown-eye allele is dominant over the recessive blue-eye allele.

Don't judge a book by its cover

Our genes – referred to collectively as our *genotype* – inform our physical appearance – what is known as our *phenotype*. From what we have learned about genetics it is also apparent that how we look – our phenotype – is not the end of the story. Many of us carry recessive genes that may be more apparent in our offspring.



IN CLASS ACTIVITY 2

GENETICS OF SELU: WORKSHEET



Grade Level: 7

Subject Area: Science

Activity time: 45-50 minutes

Setting: Indoors

Skills: Analyzing, Applying, Calculating, Classifying, Communicating, Comparing, Discussing, Gathering information, Hypothesizing, Predicting, Summarizing

Materials:

- Flashdrive with Powerpoint
- Worksheets
- Ears of Corn (or images)
- Calculator
- (16) Black vis-a-vis markers
- (16) Blue vis-a-vis markers



Activity:

Corn is a flowering plant. It reproduces like other flowering plants, by passing pollen from the male to the female part of the plant. Under the husks, each of these kernels is attached to one of the “silk” threads you see protruding from the top of the ear. The tassels on the top of the plant are the male part of the plant. When pollen from the tassels land on the silk, they fertilize the seed. Because each silk is only attached to one kernel, then each kernel has the possibility of inheriting a different genotype.

Procedure:

How do we get multi-colored corn?

Students will fill out a worksheet that investigates genotypes of corn that are expressed in the seed phenotypes. They will:

1. Learn more about homozygous and heterozygous genotypes.
2. Draw Punnett Squares to represent the outcomes of crossing different corn types.
3. Make a hypothesis.
4. Test the hypothesis by comparing the results to the physical ratios on an actual cob of corn.
5. Analyze the results.

Extension activities:

- **Recommended Video:** Unseeable Biology; TED Talk by Drew Berry (2011): https://www.ted.com/talks/drew_berry_animations_of_unseeable_biology
- DNA Learning Center / Cold Springs Laboratory. Retrieved from <https://dnalc.cshl.edu/resources/animations/>
- Weed to Wonder. DNA Learning Center Site: <http://www.weedtowonder.org>
- Storymap: Cherokee Heirloom Garden and Seed Bank: <https://storymaps.arcgis.com/stories/062261d444da4b1c880cc5351919995b>
- Reading: Eastern Band of Cherokee Farmer Fosters “Memory Banking” and Growing of Heirloom Seeds: <https://indiancountrytoday.com/archive/an-eastern-band-of-choerokee-farmer-fosters-memory-banking-and-growing-of-heirloom-seeds>
- Reading: Original Flour Corn Seeds returned to Tribe: <https://theonfeather.com/2011/06/01/original-flour-corn-seeds-returned-to-the-tribe/>





Genetics of Selu Worksheet

Names _____ Date _____ Period _____

In these activities you will investigate phenotypes of corn that are expressed in the seed. You will be given ears of corn for your investigation. Each seed/kernel on an ear of corn results from a separate fertilization event and thus represents an offspring.

STEP 1:

We begin with the parent plants, or Generation F₀. Both plants are homozygous, meaning they have two of the same alleles (AA and aa).

Parent Plants – F₀

Homozygous
AA

Dominant



Homozygous
aa

Recessive

- One plant produces **purple ears** of corn, the dominant color. Let's use a capital "**A**" (for allele) to represent this. Place it first in order within each square.
- The other plant produces **yellow ears** of corn, the recessive color, considered an absence of pigment. Let's use a small "**a**" to represent this.
- Below, draw a **Punnett square** to represent the possible offspring resulting from this cross. These offspring will be known as First Generation (F₁).

Draw a Punnett Square of possible F₁ outcome:

Purple = A

Yellow = a

Instructions:

- Label your Punnett square: "A, A" in the top greyed squares and "a, a" in the left vertical squares.
- Note the possible combinations in the bottom white squares. (Ex: AA, aa, Aa, etc.)

Questions

- What is the **genotype** of the F₁? (circle) Heterozygous (Aa) or Homozygous (AA or aa)
- What is the likely **phenotype** of the F₁? (circle dominant color) Purple or Yellow

STEP 2:

Using the information that you recorded on the first page and your knowledge of genetics, draw in the space below another **Punnett square** showing the results of crossing your F₁ generation to produce the second generation of offspring, F₂.

F₁ Generation Crossed

Heterozygous
Aa



Heterozygous
Aa

Draw a Punnett Square of possible outcome of F₂:

Purple = A
Yellow = a

1. Label the Punnett Square, this time with the "Aa" first generation allele combination. Fill out the rest of the box with the resulting outcome. ("A, a" for the top row. "A, a" for the left-hand column.)
2. What are the **genotypes** of the F₂?
_____ % Homozygous Dominant (AA)
_____ % Heterozygous (Aa)
_____ % Homozygous Recessive (aa)

STEP 3:

Using your completed Punnett square, **make a hypothesis** about the inheritance of phenotypes for F₂ and their expected percentages or ratios. (How the kernel color will likely be affected, more purple, or more yellow?). Using your hypothesis, predict what you will find in the F₂ offspring.

STEP 4:

You will now test your hypothesis and prediction made in step 3. You will get an ear of corn from the cross you diagramed in step 2 for F₂. Working in pairs or small groups of three or four, count and record in Table 1 the number of grains of each phenotype (purple or yellow) and determine the resulting ratios.

Table 1: Team Counts for F ₂ Purple and Yellow Seeds (phenotypes)		
1. Team Count - Count two adjacent rows of kernels along the length of the cob and note the color of each kernel. a. One team member slowly calls out each kernel color aloud. b. Their partner(s) should make a tally mark (++++) on the chart below under the appropriate color. (One tally mark per kernel color called out.)		
Phenotype:	Purple	Yellow
2. Color Totals: Add results for each color above and record your totals below.		
	Purple Total:	Yellow Total:
3. Total number of all kernels counted (combine total of purple and yellow above):		
4. Percentages: Divide number of Purple Kernels by Total Number of Kernels: Divide number of Yellow Kernels by Total Number of Kernels:		

STEP 5:

To test your results with a larger sample size, each group will report their counts for each kernel color and the results will be tallied with all the data from the teams.

Table 2: Class F2 Counts for Purple and Yellow Seeds		
Phenotype	Purple	Yellow
1. Class Counts		
2. Class Color Totals	Purple Total:	Yellow Total:
3. Total number of all kernels counted (combine total of purple and yellow above):		
4. Percentages: Divide number of Purple Kernels by Total Number of Kernels: Divide number of Yellow Kernels by Total Number of Kernels:		

STEP 6: ANALYSIS

Compare your expected counts / ratios from Step 3 with the actual counts from Step 5: Table 2. Are the actual counts different from the expected counts?

- Expected ratio of purple to yellow: _____
- Actual ratio of purple to yellow: _____
- Explain why:



Genetics of Selu Worksheet

ANSWER KEY (answers are in RED)

Names _____ Date _____ Period _____

In these activities you will investigate phenotypes of corn that are expressed in the seed. You will be given ears of corn for your investigation. Each seed/kernel on an ear of corn results from a separate fertilization event and thus represents an offspring.

STEP 1:

We begin with the parent plants, or Generation F₀. Both plants are homozygous, meaning they have two of the same alleles (AA and aa).

Parent Plants – F₀

Homozygous
AA

Dominant



Homozygous
aa

Recessive

- One plant produces **purple ears** of corn, the dominant color. Let's use a capital "**A**" (for allele) to represent this. Place it first in order within each square.
- The other plant produces **yellow ears** of corn, the recessive color, considered an absence of pigment. Let's use a small "**a**" to represent this.
- Below, draw a **Punnett square** to represent the possible offspring resulting from this cross. These offspring will be known as First Generation (F₁).

Draw a Punnett Square of possible F₁ outcome:

	a	a
A	Aa	Aa
A	Aa	Aa

Purple = A

Yellow = a

Instructions:

- Label your Punnett square: "A, A" in the top greyed squares and "a, a" in the left vertical squares.
- Note the possible combinations in the bottom white squares. (Ex: AA, aa, Aa, etc.)

Questions

- What is the **genotype** of the F₁? (circle **Heterozygous (Aa)** or Homozygous
- What is the likely **phenotype** of the F₁? (circle dominant color) **Purple** or Yellow

STEP 2:

Using the information that you recorded on the first page and your knowledge of genetics, draw in the space below another **Punnett square** showing the results of crossing your F₁ generation to produce the second generation of offspring, F₂.

F₁ Generation Crossed

Heterozygous
Aa



Heterozygous
Aa

Draw a Punnett Square of possible outcome of F₂:

	A	a
A	AA	Aa
a	Aa	aa

Purple = A
Yellow = a

1. Label the Punnett Square, this time with the "Aa" first generation allele combination. Fill out the rest of the box with the resulting outcome. ("A, a" for the top row. "A, a" for the left-hand column.)
2. What are the **genotypes** of the F₂?
25 % Homozygous Dominant (AA)
50 % Heterozygous (Aa)
25 % Homozygous Recessive (aa)

STEP 3:

Using your completed Punnett square, **make a hypothesis** about the inheritance of phenotypes for F₂ and their expected percentages or ratios. (How the kernel color will likely be affected, more purple, or more yellow?). Using your hypothesis, predict what you will find in the F₂ offspring.

About 75% of the kernels counted will be purple while 25% will be yellow for the phenotype. Giving us a ratio of 3:1.

STEP 4:

You will now test your hypothesis and prediction made in step 3. You will get an ear of corn from the cross you diagramed in step 2 for F₂. Working in pairs or small groups of three or four, count and record in Table 1 the number of grains of each phenotype (purple or yellow) and determine the resulting ratios.

Table 1: Team Counts for F ₂ Purple and Yellow Seeds (phenotypes)		
1. Team Count - Count two adjacent rows of kernels along the length of the cob and note the color of each kernel. a. One team member slowly calls out each kernel color aloud. b. Their partner(s) should make a tally mark (++++) on the chart below under the appropriate color. (One tally mark per kernel color called out.)		
Phenotype:	Purple	Yellow
	(Ex: tally marks totaling about 75)	(Ex: tally marks totaling about 25)
2. Color Totals: Add results for each color above and record your totals below.		
	Purple Total: 75	Yellow Total: 25
3. Total number of all kernels counted (combine total of purple and yellow above): 100		
4. Percentages: Divide number of Purple Kernels by Total Number of Kernels: Divide number of Yellow Kernels by Total Number of Kernels:		75 ÷ 100 = .75 25 ÷ 100 = .25

STEP 5:

To test your results with a larger sample size, each group will report their counts for each kernel color and the results will be tallied with all the data from the teams.

Table 2: Class F2 Counts for Purple and Yellow Seeds		
Phenotype	Purple	Yellow
1. Class Counts	(Ex: list team totals - 75x16) 75 73 76 74 etc...	(Ex: list team totals) 25 24 26 27, etc..
2. Class Color Totals	Purple Total: ex: 1200	Yellow Total: ex: 400
3. Total number of all kernels counted (combine total of purple and yellow above): 1600		
4. Percentages: Divide number of Purple Kernels by Total Number of Kernels: Divide number of Yellow Kernels by Total Number of Kernels:		1200 ÷ 1600 = .75 400 ÷ 1600 = .25

STEP 6: ANALYSIS

Compare your expected counts / ratios from Step 3 with the actual counts from Step 5: Table 2. Are the actual counts different from the expected counts?

- Expected ratio of purple to yellow: _____
- Actual ratio of purple to yellow: _____
- Explain why:

Why? The homozygous dominant (AA) is 25% + the heterozygous (Aa) (50%) likely resulting in purple, because it adds to 75% and is the dominant trait.

