



Curriculum Unit: Mendel/Punnett, Close Marriages & Clans (K'é)

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Introduction

On the first day of school, I would introduce myself to my students by introducing my four clans. Introducing yourself by clans helps establish respect, clarify family and clan relations, and tell your audience who you are and where you come from.

The Diné Standards of History and Language Concepts outline what students need to do when introducing themselves to an audience. The Navajo people have always used this practice when presenting in public.

Navajo students knowing and saying their clans is one of the topics I will use when teaching Punnett squares in the unit I developed while attending the Asking Questions in Biology seminar. Other topics include Gregor Mendel's pea plant experiments on the rules of genetic inheritance, Reginald Punnett's invention of the Punnett square, European Royal Marriages within families, Egyptian marriages, and the Native American clan system, specifically the Navajo clans known as K'é.

Rationale

I selected these topics because my students need to understand their clan system and why it is important. About 99% of my students are Navajo and 1% are others. These topics address the Navajo and Arizona State Standards, so they hit many targets with one stone. The seminar Asking Questions in Biology emphasized that students should question their learning and think about their thinking (meta-cognition). Question types vary, progressing from basic recall to complex, evaluated, and creative questions. Several questioning strategies and classroom activities help students begin asking questions and feel confident using questioning techniques for enduring understanding.

Background Knowledge & Content

Gregor Mendel

Johann Gregor Mendel was born in Heinzendorf bei Odrau, near the Moravian-Silesian border in what is now the Czech Republic (then part of the Austrian Empire).¹ He was born on July 20, 1822, to a farming family in the northern part of Germany. By age eleven, his school master was impressed with Gregor's unusual intelligence and learning ability and recommended sending him to a school that required extra expenses. Despite the expenses for his family, Johann graduated with honors.

Gregor continued his studies despite his father's request to return home. He went on to the University of Olmutz, enrolled in the philosophical institute, and studied practical and theoretical philosophy. He excelled in physics and math and graduated with high honors. While at university, Mendel met Johann Nestler, a notable biologist. Nestler was interested in heredity research with animals and plants, which influenced young Mendel.

At age twenty-two, Gregor decided to become a monk and joined the Augustinian order at the Saint Thomas Monastery. While studying theology, Gregor also had access to other subjects in the monastery libraries, such as music, philosophy, math, and botany. He had access to a vast literature to advance his education. Heredity and the traits of animals and plants played an important role in his studies, and the monastery's head friars and abbots shared his interest.

Gregor continued his studies amid financial difficulties and health issues, yet he excelled in school with high marks. He settled for an uncertified teaching job and was unable to complete a certified teaching exam because of stress and other illnesses. Gregor kept himself busy and continued with meteorology recordings, astronomy observations, caring for the fruit orchard, beekeeping, growing other flowers, and his pea experiments.

He had originally begun to study mice, but the head Abbot told him it was improper to watch mice mate and produce offspring. The Abbott stated mice were unclean and unorthodox for the monastery. Instead, Mendel deliberately chose the genus *Pisum* because it met his three basic requirements for experimental plants (simplified): consistent characters across generations (true breeding), protection from foreign pollen during flowering, and undisturbed fertility of hybrids and offspring.² Based on Mendel's own words, he was interested in proving that characters slowly changed over time, which supported Darwin's concept of transmutation of species.

He tested thirty-four varieties and carefully chose observable characters such as flowers, seeds, stems, and pods. Planting them in small beds and pots provided an environmentally controlled setting that revealed observable traits. Soil and air temperature, germination time, and light affected variations in certain plant characteristics. Mendel selected completely dominant unit-characters to study not only because they could readily be visually discriminated (from the recessive forms) but also because they were easy to symbolize, hence denote.³ When he discovered that flowers and seeds showed consistent association, he did not express them in his presentations. He explained that his plant experiments were controlled and intentionally carried out to show how hybrid offspring were arranged into separate generations and relationships.

Using capital letter 'A' and lowercase 'a' helped Mendel keep track of dominant and recessive alleles, respectively, when alleles are paired together in the genetics of diploid organisms. Mendel used this method

to catalog his experimental results quickly. As his experiment expanded with more offspring populations, he used numbers with letters and solid and dotted lines to identify groupings or differentiating characters in the hybrid.

Mendel wrote letters to Nageli (a prominent Swiss botanist), explaining that it was difficult to find suitable plants for an extensive experiment. Nageli suggested that it may support his pea plant research. Gregor spent a good portion of the rest of his life retrying his experiment with other species like hawkweed and dandelions, which are nearly impossible to control in terms of pollination, a project he later abandoned to focus on becoming an abbot until his death.⁴ It was a failure because Gregor did not know the plant produced asexually (known as apomixis) and did not produce predictable traits.

Although his research was not openly accepted during his lifetime, his work became famous after the twentieth century, and today he is known as the father of genetics. Words like hybridization, characters, heredity, cross-pollination, traits (alleles), dominant and recessive, and the law of segregation became common vocabulary in biological science.

Recessive and dominant traits

Understanding the basis of heredity was challenging for Mendel as he researched crossbreeding peas in his garden in the mid-1800s. He made key decisions that helped his work succeed. He focused on traits that were more prominent than others not seen. For example, smooth or wrinkled peas when crossbreeding. He noticed traits disappearing, then reappearing in later offspring. Mendel defined: “those characters which are transmitted entire, or almost unchanged in the hybridization, and therefore in themselves constitute the characters of the hybrid, are termed dominant, and those which become latent in the process recessive.”⁵ Mendel specified that hybrids generate two different germ cells. These germ cells contain elements of different organelles, and when some unite, they form a new embryo. The embryo forms a joint union to become a germ cell. Mendel did not know or discuss the physical basis of this observation, which he described as $A+2Aa+a$ rather than the polynomial $AA+2Aa+aa$. He depicted the organelle's separation within germ cells.⁶ Mendel's research created a foundation of genetic traits and heredity, which became widely known when his research was rediscovered. His terms dominant and recessive traits show that traits from both parents characterize hybrid offspring.

Reginald Punnett and the Punnett Square

Reginald Crundall Punnett was born in June 1875 in Tonbridge, Kent, England. He was educated at Clifton School, Bristol, and Gonville and Caius College, Cambridge, which he entered as a scholar in 1895.⁷ Later, he attended Naples Zoological Station in Italy, Heidelberg University in Germany, and began moving up the academic ladder. Punnett was associated with C. Bateson (an English Botanist) and knew he was using Mendel's work as part of his research. Punnett wrote Bateson a letter suggesting that his expertise in nutrition could help him analyze coat-color inheritance in mice. Bateson replied by offering a partnership in his breeding experiments.

Punnett was enthused and refused Bateson's salary offer. Bateson and Punnett studied Mendel's work on peas and coined the term partial coupling. The analysis of the various ratios that characterized Mendelian

inheritance was much facilitated by Punnett's simple square diagram showing how gametes combine to make zygotes or sometimes how genotypes at two loci combine to make zygotes.⁸ As Punnett published more examples of grids, his first diagram was a simple two-by-two and then a four-by-four diagram of flower petals. As he analyzed more plant examples, his grids became more complex, like a nine-by-nine grid with diagonal lines within it. In his second edition of his *Mendelism*, he used a different format showing 9:3:3:1. The squares he created vary in size, and some squares were within squares (smaller into larger ones). He called the squares' construction chessboards because the diagonal, crisscrossed lines and capital and lowercase letters appear within the diagrams.

Punnett did much work and published it in books. He contributed by comparing anatomy, butterfly mimicry, and the genetics of fowl, rabbits, and sweet peas based on Mendel's research. He defended Mendel's work when many scientists frowned upon it, because Mendel presented his research and later Darwin presented his work on evolution. Darwin's work became more widely discussed than Mendel's. He did much to introduce genetics to the public and to commercial breeders and, in so doing, helped create opportunities in biological research that geneticists today enjoy.⁹ Darwin's papers were popular among scientists who attended his presentation, whereas Mendel's papers were stored and some were burned when he died.

Mendel and Punnett studied genes in plants and identified dominant and recessive alleles. Future research on the genetics of more plants, animals, and humans has revealed more of what biology has discovered. Marriages within families have been an ongoing practice since the beginning of man. In the Bible, when man first existed, he married his sister, and sisters married brothers. Then, during Moses's time, God commanded that close-relation marriages be forbidden. In general society, these marriages are frowned upon. These inter-generational marriages created diseases and sicknesses, which led to mutations. The Ptolemy dynasty, cousin marriages, and tribal marriage continue to practice close family marriages.

Ptolemy Marriages

Royal marriages between close relatives were common during the dynasty. Kings married daughters, sisters, or mothers, and queens married sons, brothers, or fathers. These common marriages had negative impacts on their children. Children were too weak to survive for days, weeks, months, and even years. When the children did live to adolescence, teen, or adult years, they were killed by unknown assailants, jealous family members, or sickness, or in battles.

The reign of kings and queens during different dynasties was about five or six hundred years. The Greco-Macedonian dynasty of the Ptolemies, which ruled Egypt from 322 until 30 BCE, established a practice of incestuous marriage in the royal house early on.¹⁰ The Ptolemies were from Greece and overtook the Egyptian empire for hundreds of years.

Children of royal marriages developed physical and mental traits that were frowned upon. The physical traits of obesity and shortness in height were the results of incest. The potbelly known as *Physkon* made Ptolemy fat. Ptolemy VIII and his son showed potbelly physiques that made them unfavorable kings. Bust statues of the kings show excessive facial plumpness. Their mental traits included aggression, a mindset of securing the throne solely for themselves, and keeping the royal blood pure. Incest and power were the Ptolemy dynasty's goals, and they kept heirs in the lineage.

The royal family during the dynasty named heirs after themselves. For example, Ptolemy I to Ptolemy XV and the many Kleopatras. These name redundancies ensured the Ptolemy genealogy continued. A Ptolemy king brings his son from Greece to marry his daughter to keep the bloodline going. Many of these marriages were not out of love but for family convenience. Even the Greek and Egyptian gods' male and female siblings were in relationships. Zeus and Hera, Isis and Osiris were siblings.

Cousin Marriages

Consanguineous marriages have been practiced since the urbanization of ancient cities like Mesopotamia, Egypt, and Tenochtitlan in the Inca Empire. These cities had the luxuries of comfort, land wealth, religious demands, royal bloodlines, and military strength. To sustain luxury and comfort, families arranged close marriages among cousins.

Some countries established laws prohibiting cousin marriages—countries like the United States, China, and North Korea. United States made it illegal and a criminal offense, and China created a one-child certificate program hoping to reduce cousin marriages. Other countries have continued the traditional practice for hundreds of years. Pakistan, Morocco, Turkey, and other smaller countries continue to practice cousin marriages.

As parts of the world continue cousin marriage, concerns about inbreeding and the health of the next generation remain a subject of study. Medical and research scientists are studying the effects of cousin marriages within close families. Researchers need to study social, economic, demographic, reproductive behavior, and early- and late-onset morbidity and mortality.¹¹ As studies reveal from scientists, the overall population of marriage unions is in poor rural communities. These areas have low education, early marriage and early childbearing, short birth intervals, and yearly births. These factors create large families and higher rates of infant and childhood death.

An additional finding is early termination of pregnancy with cousin marriages, and the couple has a lower immune system known as human leukocyte antigen (HLA). HLAs are special proteins that cover the surface of a cell and help the immune system differentiate between your own healthy tissue and a foreign invader.¹² Scientists suggest closely monitoring breeding to prevent pathogens from entering the body.

Avoid cousin marriages and inbreeding, and prefer a healthy lifestyle. Knowing your lineage and family genealogy, and living with native tribes, can help protect against certain sickness and disease.

Native American clan system

Some native American tribes have a clan system that establishes relationships through marriage within the family. A clan cannot marry into the same clan, usually the same clan as the matrilineal clans and close paternal clans. Most southwestern tribes have matrilineal clans, and some eastern tribes have patrilineal clans. Clans can be a large family or many families, with about fifty to a hundred people. Some tribes have

large clusters of clans, like the Navajo, while others have three or five. The Mohawks have three clans, Turtle, Bear, and Wolf. Certain clans have status like land for farming and hunting, wealth like livestock, money, material goods, a healer (medicine and ceremony), and/or leadership positions. Clans are expected to show hospitality to clans that have the fewest members and to adopted clans. Clan names distinguish relations of kinship, lineage, and which clan not to marry.

Common clan names are usually animals, birds, totems, nature (water, rock, plants, mud, salt, mountain), patterns of human movement (folding arm, one walks around), and structures (towering house, red house) and names of adopted tribes (Naakai dine'e, Nooda'I dine'e, Naashgali dine'e). Most tribes have stories about their clans and how they originated when the tribe came into existence. Some clans are identified by sacred colors, animal protectors, or a weapon.

In some tribes, clan mothers, aunts, and grandmothers raise children. Other tribes raise children within clan families (parents, matrilineal grandparents). Clans are expected to care for all children, especially those without parents or grandparents. Women and children were valued; they kept the next and future generation going.

During early times, Native American tribes controlled marriages to ensure future generations continued. Parents and relatives carefully selected couples to prevent incest. Incest consisted of marrying within the known cognatic personal kindred, a person's own matrilineal clan, or any of the clans to which a person's clan was "closely related" or "related."¹³ Marriages were controlled largely by the older generation, usually through a contract agreement between families to ensure their children followed the social norms of clan relations. Children were taught and trained at an early age to follow the norms of the tribe, bands, and clan system.

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Within some tribe's children are raised by clan mothers, aunts, and maternal grandmothers. In contrast, other tribes raise children within clan families (parents, matrilineal grandparents). Clans are expected to care for all children, especially those without parents or grandparents. Native people valued women and children.

The Apache

The Apache tribe has about nine cluster bands with different names, located in southern Arizona, New Mexico, Texas, and Oklahoma. These bands are federally recognized tribes: Cibecue, San Carlos, White Mountain, Tonto, Chiricahua, Mescalero, Jicarilla, Lipan, and Kiowa Apache.

These bands married into other bands from the 1700s through the 1800s. Other tribes, such as the Navajo, Comanche, Yavapai, and Pueblo, invaded them. Other intruders were Mexican, Spaniards, American soldiers, and white settlers. Apache bands began to dwindle, and to protect and sustain their groups, they married within their bands. The eight bands in the region helped sustain one another when a band began to dwindle. For example, Geronimo's family was killed by the Mexican. He lost his wife, children, and mother. He remarried and had multiple wives and continued to fight the Mexican and American soldiers until he surrendered.

As settlers encroached onto the land, the Apache rebelled and captured women and children to expand their bands. Women were married into the band and raised their family. Her clan was adopted into the band, adding a new clan to the tribe. The captured children were replaced with families who lost a member and were adopted into the band. The Apache are a matrilineal family; her family cares for the home, children, and parents.

The Navajo

The Navajo people are known as the Diné, meaning “The People,” and they refer to each other as the Diné. The Navajo clan system has about twenty-three clan groups, composed of original clans, subgroup clans, and adopted clans from other tribes. Children are told the origins of the clans. According to a legend, a woman named Changing Woman created the four original clans,

Changing Woman created four clans, which are Kin Yaa’ Aanii (towering house people), Honaghaanii (he walks around you people), To Di Ch’ii Nii (bitter water people), and Hash Tl’ish Nii (mud people). Changing Woman created the four clans from portions of her body. She gave each clan a sacred color cane, an animal protector, and special gifts of cognition, interpersonal skills, artistry, professionalism, and creativity.

First, Changing Woman rubbed her chest to create the Kin Yaa’ Aanii clan and was given a gish (cane) made of white shell, with special gifts of leadership, guides, and teachers for the people. The animal protector is the shash (bear), named dzil yaah naaghahi, meaning “one that walks on the mountains.” The bear is a strong symbol, and its claws and coat appear in sand paintings for the Mountain and Bear ceremony. Some people say the keeper of the Gish used it to dig for water but found none. The keeper grew frustrated, threw the Gish against the canyon, and mistook it for a home structure. The clan is now known as Kin Yaa’ Aanii (towering house clan).

Next, she rubbed her back to create the Honaghaanii clan and was given a gish (cane) made of turquoise with special gifts of songs and prayers to become medicine men and women. Turquoise is worn to protect the traveler and speaker for songs and prayers. The animal protector is nash doi tsoh (mountain lion) as their symbol of protection and healing, which was named “one who walks around you, clan.” Ceremonies and songs tell of the mountain’s special powers, including the ability to see evil in the darkness.

Then, she rubbed her right underarm to create the To Di Ch’ii nii clan and was given a gish (cane) made of abalone shell with special powers of philosophers and educators to share their knowledge. The animal that protects is diyoosh (bull snake) or ma’ii’tsoh (wolf). When a wolf howls, it signals to turn back from battle, a raid, or a hunting trip. Snakes are known as evil, but a bull snake is respected and harmless. When it is about, it represents lightning, and when it rains, respect is for the bull snake. The clan To Di Ch’ii Nii originated when a spiritual leader used the gish to dig for water, and bitter water spouted from a hole. The clan is now known as To Di Ch’ii Nii (bitter water).

Last, she rubbed her right underarm to create the Hash tl’ish nii clan and give a gish (cane) made of jet-black stone with special skills, gifted, and creativity to become rug weavers, artists, and agriculturalists. The animal protector is dah sani (porcupine), and sani means old. It is known for being wise, skillful, and able to outsmart the enemy. The under hair, bristles, whiskers, and quills are used for healing in ceremonies. They apply burnt quills to infected sores, and inhale the smoke to clear congestion from colds. During the journey back to their homeland, the gish dug for water, and the hole spouted muddy water. The clan is known as Hash tl’ish nii (mud people clan)

Within these four original clans, additional clans are added. For example, I am Naakai Dine'e (the Mexican people), so I cannot marry my own clans. My clan cluster includes six additional clans. Then I cannot marry my father's clan because I was born into it. His clan is Dibe Lihini (black sheep people). Within my father's clan, there are eight additional clans in his cluster. My mother's father's clan is To Di Ch'ii nii (bitter water), which has fourteen additional clans in its cluster, and my father's father's clan, Tlizi Lani (many goats people), has eight additional clans in its cluster. I cannot marry into my four main clans.

Marriage

Some Navajo men have about four to five wives, and most have two. Two or more wives were common in the mid-1800s because Navajos were returning from their incarceration during the Long Walk to their homeland. Girls were married at an early age, between twelve and fourteen, after their kinaalda (womanhood) ceremony. Some of these men were hataaliis (medicine men) who could afford the payment for young wives. Clans played a prominent role in arranging many betrothals. These wives were usually sisters.

Their families arranged a common marriage between a young couple, and the uncle set the value of the present. At the time, horses, silver jewelry (concho belt), and saddles were valuable. Today, horses, cattle, turquoise jewelry, and money are what the groom gives to the bride's family.

Teaching Strategies

The teaching strategies (Inquiry Chart and Exploration Chart) are from the Guided Language Acquisition Design model.¹⁴ The frame uses visual charts with color-coding of the information on the charts. The teacher displays these visuals on the classroom walls during the unit. The charts include questions the teacher and students generate.

The Inquiry Chart is a strategy used to assess student background knowledge and sets the purpose for learning the content introduced. The teacher creates an opportunity for writing and questioning. The teacher sketches two columns on a poster chart using two colored markers. In the top left column, the teacher writes, "What do you know about scientists conducting genetics research?" Then, in the top right column, the teacher writes, "What do you want to know **more** about scientists researching genetics?" Students orally state their answers and ask questions about the prompt. Then the teacher writes down the exact wording students use.

As the teacher completes the chart, students initial their sentence and question. The teacher reviews the chart and marks where the answer is found on other charts for the sentences and questions. The teacher asks students basic wh- questions. As learning progresses, students ask critical-thinking questions, which are added to the inquiry chart. Questions from Bloom's Taxonomy levels four, five, and six are critical-thinking questions.

Level four: Apply, when students use the information differently than what was learned. Question examples: What questions would you ask if Mendel were alive now? Which actions would you take if he did not use pea plants? Which factors would you change in his pea experiments?

Level five: Analyze, when students break down information into parts to deepen their understanding and relationships. Question examples: Explain what must have happened when Mendel used a plant other than

peas. What conclusion can you draw when the Punnett square shows three white flowers and one purple flower? What was Mendel's motive to conduct his pea plant experiments?

Level six: Create, when students create individual ideas or viewpoints from prior learning. Question examples: What changes could you make to revise the Punnett square to help you understand it better? Develop a plan for a pea garden to help you understand ways to create a Punnett square label? Devise your own way to create a Punnett square from self to parent?

The Exploration Chart is a strategy used to set the purpose for learning vocabulary and background information, ask questions, and answer questions. First, post photos of a Punnett square and the Navajo clan chart on the wall with no wording. Students are given time to view the photos, then are asked to read the exploration chart poster. First, it reads Observation next, what are you wondering? Then what are your predictions? Students discuss and share their answers with the table team. The teacher selected some heads using a spoon with numbers marked on them. (Number head is when students are given a number: one, two, three, or four) For example, if it is three, all students will share what the team observed in the photos. The teacher writes their observation statement on the chart. Next, students are to ask a question about the photos: What are you wondering? Students state, I am wondering...? After all the threes have given their team questions, the teacher writes their questions on the chart. Then the teacher selects another spoon, maybe a one. All the ones answer, "What are your predictions?" The teacher writes their answers on the chart. The teacher reviews the chart with the class, so students know the process for completing an exploration chart. In the classroom activity, students will independently complete an exploration chart after their team task.

Punnet Square

First ask questions: How does genetic information impact an offspring's trait? What are the possible outcomes of the dominant and recessive traits? Why do we use capital letters for an allele and lowercase letters for the other? What do the boxes in the Punnett squares represent? What is the physical appearance or observable trait called? What is the ratio of various observable traits? Can you correctly complete the array for gene combination, or genotypes, for their offspring? What phenotype, or evidence of a dominant or recessive trait, will each combination have?

These questions are written on a chart and used as an active questioning chart, with questions answered and more added as the class progresses through the activity. Students will receive background vocabulary related to the Punnett square activity so they can familiarize themselves with what the activity represents. The teacher will model several.

Then, the teacher displays a complete diagram of Parent 1 and Parent 2 as an example of how students will complete their Punnett square activity. The squares represent possible combinations of genes that offspring can inherit from two parents. Students will complete a basic Punnett square using their parents' genotypes: free and unattached earlobes, black and brown eyes, frizzy and straight hair. As students learn about traits, they will complete the activity. As a class, conduct a challenging activity with the teacher. Complete a Punnett square activity on rabbits with a solid coat and stand-up ears, and a spotted coat and floppy ears. After completing the chart, students answer questions about the diagram. Based on their questions, students can move on to the strawberry activity about food. Before, during, and after the activities, the teacher and

students are questioning during the lessons.

Classroom Activities

Guided Language Acquisition Design strategy for Picture File Cards. Students are given four to six cards within their groups. They view and share the cards and begin discussing the topic to build background knowledge. Next, they ask questions about the images and share them with their table/group. Then students begin to sort the cards into themes or topic clusters and explain why they divided the cards into particular groups. Vocabulary usage, prediction, inference, and theme topics are generated and shared. Students ask questions about the cards, write them on Post-it notes, and rotate them within their table team. The team answers the question, then adds more questions to the Post-it and rotates again. When the Post-it makes a complete circle, using numbered heads, a student stands.

The Punnett square strawberry activity is challenging and complex. Strawberries show more DNA than other fruits. Strawberries are octoploid, meaning they have eight copies of each chromosome. Students will learn that food has DNA. The food they eat has DNA, and they will learn to extract it from strawberry cells. Students will learn the basic method of extracting DNA. The young scientists will learn how actual scientists extract DNA from organisms. The long, thick fibers of strawberries are soft, smooshy, and easy to pulverize. They have large genomes, octiploid. Using soap helps break down the cell membrane. Students will learn how to extract DNA strands from strawberries.

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Appendix on Implementing State and Diné Standards

My research takes me into the Pedigree realm of genetics to analyze disease inheritance. Then, tracing the roots of why not marry into close family and relatives creates diseases like hemophilia. The Navajo Clan System, known as K'e, and European Royalty marriages are examples I can use to teach teachers and students why close marriages and relationships are frowned upon and, in some cultures, forbidden.

His explanation of his pea plant findings and the Punnett Square model targets the L3 standard: Genetic information is passed down from one generation of organisms to another. After learning the L3 standard, then L1 how organisms are organized, L2 organisms

The Navajo standards:

Culture: Concept 2 - Nahat'a (Nahat'a bits'aagdoo anootiligii bik'ehgo anisht'ee dooleel. (I will apply and practice the Diné way of life through planning). PO 2. Shil' iliig K'snisdzin dooleel. (I will express appropriate kinship terms).

History: Concept 1 - Nahdee' nihidine'e be'ia' adayiilaa yee baa akonisingo baa nahaashine dooleel. (I will explore and explain how Dine people and historical events have influenced the development of my community). PO 1: Adoone'e nishlinigii do hane' bedadeeti'gii shil beehozin dooleel. (I will explain my maternal clan family and its historical origin). Concept 2 - Nihe'e'ool'iil dahodiyingo nahaz'aagoo do nihikeya bika'a'goo digi baa akonish dooleel. (I will understand connections between my culture, sacred sites, and historical events). PO 4: Adoone'e nishlingii binahji' k'e shi'do'nii dooleel. (I will establish kinship with my peers).

Language: Concept 4 - Shee'o'ool'jil haisidigii do ashlaagi baa nahashne

dooleel. (I will appropriately express my interpersonal communication by relating to cultural experiences). PO 3: Adeehodeeziil doo shik'ei baa hashne' dooleel. (I will introduce myself and my extended family).

Using visuals and explaining the Navajo clans of K'e on a Navajo Kinship Diagram will help students better understand their families and extended families. The chart teaches students Navajo words for family

members, such as self (shi), siblings (shadi, shinai, shideezhi, shisili), aunts and uncles (shida'i, shima yazhi, shibizhi, shizhe'e yazhi), and grandparents. Creating Punnett squares from self to parents, then to paternal and maternal grandparents, showing dominant and recessive genes, will help students begin to see the connections.

Extending clan relationships with other tribes is another example of how native tribes explain their clan connections. The Apache and Navajo are two examples of tribes with a clan system.

Notes

- 1 Johann Gregor Mendel: paragon of experimental science (page 3)
- 2 Gregor J. Mendel – Genetics Founding Father (page 47)
- 3 Mendelism: New Insights from Gregor Mendel's Lectures in Brno (page 4)
- 4 The Study of Genetics: A Historical Perspective (page 2)
- 5 Gregor Mendel and the concepts of dominance and recessiveness (page 1)
- 6 Gregor Mendel and the concepts of dominance and recessiveness (page 1)
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- 13 The Clan System as an Epiphenomenal Element of Western Apache Social Organization (page 5)
- 14 Brechtel, Marcia. *Bringing It All Together: Language and Literacy in the Multilingual Classroom*.

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