Appendix D

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| **Teacher Candidate Name: Name Removed** | **Lesson Title: Punnett Square Introduction** |
| **(K-12) Course name: Life Science** | **Grade Level: 9-10** |
| **Topic: Punnett Squares, Phenotype/Genotype ratios** | **Day in Lesson Sequence: 12** |
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| **Lesson Rationale:** What is the central focus of the lesson? What is the purpose for the content you will teach? How are you helping students build conceptual understandings, procedural fluency (if relevant), and critical thinking skills in this lesson? How will students make connections to other course content and to their experiences? What requisite skills do students need in order to access the lesson and participate fully? Where does this lesson fall within a learning sequence (What would come before? What will happen after?)?  |
| This lesson is designed to build on students’ understanding of the connection between genotype and phenotype as well as introduce the use of Punnett squares in genetics. During the lesson the students will discover the predictable phenotypic and genotypic ratios that occur during monohybrid crosses when the genes show simple dominance. Students will determine these ratios independently before pairing up to discuss their discoveries, a large group discussion will follow to highlight that these ratios occur every time this type of cross is done. Students will then be given a brief history of Mendel and how he discovered these ratios through his garden experiments. To apply the information they learned in the lesson students will be given the chance to either find the predictable genotypic ratios found in sex-linked traits OR show how the predictable ratios discovered in class can help to determine an unknown genotype. |
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| **Content Standards:** (State, Common Core, and/or National Standards): Cite constellation of standards, using the numeric code reference as well as the text, that are the focus of this lesson. If addressing only a part of a standard, italicize that part.  |
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| **Content Objectives:**  What do you want students to be able to *do* as a result of this lesson. *Use one of the following sentence frames:*Students will be able to (assessable action).  |
| SWBAT Use Punnett squares to determine phenotypic and genotypic ratios.SWBAT Explain the relationship between dominant and recessive alleles and how that relationship determines phenotype in simple dominance.SWBAT Use predictive genotypic ratios to determine an unknown genotype given a known dominance relationship between alleles. |
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| **Assessment & Feedback** |
| **• Prior Knowledge Assessment:** How have/will you determine what students already know, think, or can do relative to each objective? What misconceptions, alternative conceptions, or common errors does research show you could expect students to demonstrate related to the objectives? How will you plan to reveal and address misconceptions and common errors during the learning sequence? |
| Students will help define genetics terms that they have already been exposed to throughout the unit. As the students define the terms the instructor can clarify any misconceptions. The vocabulary includes:* Genotype
* Phenotype
* Allele
* Trait
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| **• Formative Assessment:** In what ways will you informally and formally monitor student progress towards the objectives during the lesson? How will those assessments inform your teaching decisions during the lesson and in planning subsequent instruction? How will your students be able to use self-assessment and teacher feedback to deepen their understanding, refine their skills, and demonstrate subsequent growth?  |
| * During the individual and group work the instructor should walk around to ensure the students are setting up the Punnett Square correctly and are using the technical vocabulary.
* After completing the small group work students will share out what they found. This is a form of informal assessment that allows the instructor to check for understanding.
* At the end of the lesson students will be given a take home assignment in which they will determine genotypic and phenotypic ratios under different circumstances (sex-linked traits and unknown parental genotype). This is a form of formal formative assessment. The following day the class will go over what they found in the assignment, allowing the instructor to check for understanding at the group level before looking over the individual answers.
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| **• Summative Assessment:** What final evidence (or pieces of evidence) of student mastery of these objectives will you collect (in the future)? How will your students be able to use self-assessment and teacher feedback to deepen their understanding, refine their skills, and demonstrate subsequent growth? |
| There will be a test at the end of the unit containing a variety of questions on the topics covered in this lesson, examples include:* A multiple choice question in which students will need to recall the genotypic/phenotypic ratios of a monohybrid heterozygous x heterozygous cross.
* A true-false question comparing genotype and phenotype.
* A free response question in which students will have to show how to use genotypic/phenotypic ratios to determine an unknown genotype (of an individual with the dominant phenotype), students will need to show their work.
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| **Provisions for Learning Differences:** How does the design of instruction meet the needs of individual students and groups of students with particular learning needs (English Language Learners, students with IEPs, students with 504 plans, underperforming students, students with gaps in academic knowledge, struggling readers, and gifted students in need of greater support or challenge)? What adaptations and modifications will you make for specific individuals or small groups of learners?  |
| Students with EBD:* For the partner discussion, the student will have the opportunity to work alone if they need to. They will also have access to other support technology they might need (for example hand fidgets). This protocol would have been established at the beginning of the year.
* If at any point the student feels they need to leave the room they will have the opportunity to go to their “safe space”. Later the instructor should follow up with the student and their special education teacher to determine what triggered the incident, how to prevent it from happening in the future, and to go over any material they missed from the lesson.

Students with Learning Disabilities:* All information will be given visually and verbally.
* The students will have multiple examples to work through, increasing their exposure to the material.
* Pairing students up and then sharing out to the large group will help address potential misconceptions.
* The instructor should ask multiple clarifying question throughout the lesson.
* The instructor should extend the time the students have to work on the Punnett squares as needed.

Students with ADHD:* Unfortunately this lesson keeps students in their seats. To counter this the instructor could use “clock-partners” or another way of pairing the students that gets them to move.
* The students may also be allowed to move to the lab area during partner work.
* Hand fidgets will be available for students as needed.

Students who are ELL:* All directions will be given verbally and visually.
* There is no reading during the lesson that is not reinforced either verbally or pictorially. This will help these students connect the verbal word to a visual representation.
* ELL students will have multiple potential partners (based on “clock-partners”), both primary English speakers and other students with their primary language. Students can be paired appropriately based on the content of the lesson. During this assignment, due to the large amount of technical vocabulary, the instructor should consider pairing ELL students together while trying to pair more proficient English speakers with less proficient speakers.
* The assignment at the end of the lesson will be available in the student’s primary language if needed.

Students who struggle with reading:* There is not much reading in this lesson. All written instructions will also be given verbally.
* For the assignment at the end of the lesson a copy with the vocabulary and critical information, such as the genotypes of the individuals, underlined or in boldface.
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| **Materials:** What materials will you need in order to teach this lesson? What materials will students need?\*\*ATTACH ANY HANDOUTS, SLIDES, READINGS, ETC. NECESSARY TO COMPLETE THE LESSON.\*\* |
| Teacher materials:PowerpointSmartboardWhiteboard markers, multiple colorsFor each student:Assignment handout (attached)Students will need:PencilScience notebook |
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| **Learning Activities** |
| **Time** | **Learning Activities***For each section, clearly articulate:** *What the teacher will be doing;*
* *What students will be doing;*
* *Directions that will be given (including time cues, getting materials, forming groups, determining roles, tasks to be completed, etc.)*
* *Examples and/or information the teacher will provide;*
* *Questions and prompts the teacher will pose before, during, and following completion of an activity to elicit student articulation of their learning;*
* *Expected on and off-target student responses; planned teacher interventions;*
* *Any additional information that a principal, mentor teacher, or substitute teacher would need to observe or to carry out the lesson flawlessly*
 | **Rationale***For each learning experience (there may be multiple learning experiences within each section), clearly articulate:**• why you selected this instructional strategy;**• how individual and group learning needs are met,* *•  what learning you want to result from the experience.* |
| Minutes**0-5**5 min | **Lesson Launch** How will you motivate your students? How will you connect to your students’ previous experiences/background knowledge? How will you help students transition from the previous lesson to this one? |  |
| After the bell rings the class will start with the usual “centering break”. I would then bring to the class’s attention that I have not written the day’s objective because they will discover it through the lesson. We will then review the vocabulary that they have learned previously and will be used in the activity. This vocabulary is:* Genotype
* Phenotype
* Allele
* Trait

I will ask the class to define the words and write their definitions on the board. | * I start every class with a 30 second silence break in order for the students to get in a good mindset.
* Pointing out that they will be discovering the objective of the lesson should catch their attention.
* Having the students define the vocabulary allows them to understand the words more completely. It also allows me to check for misunderstandings the students may have. Writing down their definitions, as well as repeating them aloud, caters to visual and auditory learners.
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| **5-7**2 min**7-10**3 min**10-15**5 min**15-22**7 min**22-25**3 min**25-28**3 min**28-30**2 min**30-35**5 min**35-45** 10 min | **Instructional Task(s) Sequence** What learning experiences will you engage students in that will help them build the understandings and skills needed to meet the content and language objectives?  |  |
| **Discovery:*** Following the vocabulary review I will put up a picture of an alien and have volunteers describe a few traits (3-5 depending on class size).
* I will then describe the following hypothetical scenario:

“This alien is part of a species that has two varieties of the traits that we described, the version in this picture are the dominant phenotype. Now what we are going to do is come up with the recessive versions of these traits.” I will then choose students to make up a recessive version of the traits the class choose. I will draw an alien with these traits on the board. I will then list the homozygous genotype of each trait (the first cross will only be homozygous individuals).* Following this I will walk through how to set up and complete a Punnett Square using one of the traits the class described. I will then describe what phenotypic/genotypic ratios are and ask the class to tell me the ratios produced by this cross (it will be 100% heterozygous 100% dominant phenotype). I will then set up a Punnett Square for a cross of the F1 individuals, but stop before completing it.
* The following directions will then be given to the students orally and on the board:

Now, choose a trait that you are interested in and complete a cross just like the one I did on the board. Write down the phenotypic and genotypic ratios of this generation. Then set up and complete a cross of this second generation, write down the phenotypic and genotypic ratios. Eyes up when you are done.I will walk around the room to make sure that students are on task.* Once all of the students are done I will have them pair up with someone who did the same trait as them, moving around the room if necessary. They will then compare the ratios that they found, specifically the phenotypic ratio because there might be some confusion in regards to the heterozygous individuals. I will continue to walk around the room monitoring.
* Once they’ve had a chance to share in their pairs I will ask them to share out the trait that they choose and the ratios they found. I will write down the information on the board.
* Once every trait has been described I will ask what the class notices about the data, guiding them to the conclusion that all of the ratios are the same.

**Clarification:*** Following the large group share I will have the students return to their desks if they have moved. I will then explain that the ratios they found were the same ratios Mendel (who will be addressed the following day) found in his garden.
* I will further explain that these ratios are powerful tools the geneticists can use to answer questions. At this point I will hand out the “Genotypic Ratios” assignment (attached). I will then explain that these are two examples of those kind of questions.

**Application:*** For the students’ exit work they will be asked to complete one of the questions on the assignment. Question 1 contains more vocabulary and a new, unexplained, concept and might be viewed as more difficult than question 2. This work will not be graded for correctness, only completion, and the students will know this. The questions will be done on scratch paper and turned in to me with students’ names. The assignment sheet should be put in their lab notebooks
* I will encourage the students to attempt the other question in their notebooks if they finish early, as either type of question might be featured on the exam. This question should be answered in their lab notebook. I will be available for any student who has questions.

  | * This is a good attention getter that makes the students feel involved in the lesson and gives them choice.
* This narrative is mostly to keep kids’ attention, also allows for some humor because I am a terrible drawer.
* This will be the first two Punnett Squares the students have seen so they will need to be shown how to do it. I will set up but not complete the second square because it would give away the lesson.
* Allowing the students to choose a trait should increase participation. It is important to make sure no one is doing the example trait. Having the students work individually will allow them to independently problem solve. Walking around and observing is an informal formative assessment.
* Having the students pair up will give them a chance to check their work and discuss potential missteps before sharing with the group, increasing their confidence with the material.
* It is important to verbally repeat answers and write them down to accommodate different learning styles. If a group gives a wrong answer open up the question to the rest of the class to answer, another group might have the correct answer and be able to describe the process.
* If it has not already been pointed out by the students, it is important to draw their attention to the consistent ratios produced by this type of cross.

- * This kind of connection to an historical scientist can be interesting for some students, it makes the activity seem less like busy work.
* Connecting science activities to real world applications is an important step in keeping students engaged and interested in the topic.
* This choice will allow the students to work on a problem that is appropriate for their level of understanding. It would be unfair to grade this assignment for correctness so shortly after teaching the concept. The students have not had enough time to practice.
* Encouraging them to complete both questions, and giving a practical reason, should keep students who finish early on task.
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|  | **Lesson Summary** **and Closure** How will key points of the lesson be articulated and summarized? By whom? How will you help students transition to the upcoming lessons on this topic?  |  |
| In closure I will ask the students to think of some traits that humans have bred in to domestic animals and how the knowledge they gained today relates to it. I will encourage them to think of at least 3 traits that we may discuss in the classes to come. | * This closing connects the material to their daily lives, encourages them to continue thinking about the topic, and personally invests them in the unit to come.
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| **Management and Safety Issues:** Are there management and safety issues that need to be considered when teaching this lesson? If so, list them. What will you do to prepare students for these issues?  |
| Other than reminding and ensuring that students move around the room carefully and respectfully there is no safety concerns for this activity. |
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**Genotypic Ratios Assignment**

1. Colorblindness occurs much more frequently in men than women, in fact men are roughly 16 times more likely than women to be color blind. This is due to the fact that the gene for colorblindness is what we call “sex-linked”, meaning it is on the X or Y chromosome. We will get more in depth with these genes later in the unit, for now you just need to know that colorblindness is a recessive trait on the X chromosome. For this assignment I would like you to determine the genotypic ratios you would expect sex-linked traits to have if:
	1. The mother is homozygous dominant (XX)
	2. The mother is heterozygous (Xx)

In both situations assume the father has the genotype XY.

1. In today’s class you discovered the genetic ratios that occur when you cross individuals of certain genotypes. In all of the examples we did you knew what genotypes we started with, but in laboratory that is not always the case. A lot of genetics experiments are run on fruit flies because of their relatively small genome. When a lab wants to do an experiment they can order fruit flies with the exact genotype they want. This might raise a question in your mind: if the flies have a dominant trait, how do you know if they are homozygous or heterozygous? The answer, of course, is in their cross ratios. For this assignment I would like you to determine the genotypic ratios you would expect to find if you crossed a homozygous recessive individual (aa) with:
	1. A homozygous dominant individual (AA)
	2. A heterozygous individual (Aa)

We will discuss what these ratios tell us about the parents tomorrow.

**Genetics Unit Final Project (Copy A)**

For this project you will be inventing an imaginary creature and describing how traits in this species are expressed and inherited.

Instructions:

1. Invent a creature, make up a name for it, and describe 3 traits of the organism.
	1. One trait will show simple dominance.
	2. One trait will show incomplete dominance.
	3. You choose the dominance relationship for the final trait.
2. For one of these traits assume it has the following DNA sequence:

**C C T A C G G T C A G G T T A C C A C T G**

Take this gene through the process of Transcription, be sure to list the steps of Transcription and write the complete RNA sequence.

1. Translate the RNA sequence you created in the previous step. Be sure to list the steps of Translation and write the complete Polypeptide chain.
2. For each trait:
	1. Describe the type of dominance it has.
	2. Describe the phenotypes expressed by homozygous dominant and homozygous recessive individuals.
	3. Complete a monohybrid cross, give the genotypic and phenotypic ratios produced by this cross.
	4. Complete an F1 x F1 cross, give the genotypic and phenotypic ratios produced by this cross.
3. You may complete these tasks either in narrative format or as a poster. You can receive extra credit for drawing an example of a creature that has the heterozygous genotype of all 3 traits.

**Genetics Unit Final Project (Copy B)**

For this project you will be inventing an imaginary creature and describing how traits in this species are expressed and inherited.

Instructions:

1. Invent a creature, make up a name for it, and describe 3 traits of the organism.
	1. Two traits will show simple dominance.
	2. One trait will show incomplete dominance. Consider using a color trait for this.
2. For one of these traits assume it has the following DNA sequence:

**T A C G G T C A G G T T A C C A C T**

Take this gene through the process of Translation, be sure to list the steps of Transcription and write the complete RNA sequence.

1. Translate the RNA sequence you created in the previous step. Be sure to list the steps of Translation and write the complete Polypeptide chain.
2. For each trait:
	1. Describe the type of dominance it has.
	2. Describe the phenotypes expressed by homozygous dominant and homozygous recessive individuals.
	3. Complete a monohybrid cross using a Punnett Square, give the genotypic ratios and phenotypic ratios produced by this cross.
	4. Complete an F1 x F1 cross (using the genotypes produced in the previous step) using a Punnett Square, give the genotypic ratios and phenotypic ratios produced by this cross.
3. You may complete these tasks either in narrative format or as a poster. You can receive extra credit for drawing an example of a creature that has the heterozygous genotype of all 3 traits.